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ABSTRACT

This study aimed to produce a significant improvement in the educational achievement of Hawaiian preschool children in 2 years, through implementation of a communication program in five preschool classes serving approximately 100 children. The six components of the program were: (1) an enhanced hearing loss and middle-ear disorder and speech disorder screening program; (2) follow up to ensure that screened children received appropriate medical care; (3) reduction of classroom ambient noise levels; (4) amplification of instructional speech to an educationally effective signal-to-noise ratio; (5) special communication-enhancing classroom teaching techniques and equipment for use with children experiencing moderate speech and hearing difficulties; and (6) an individualized home and school communication therapy program for children needing it. Although not all the proposed interventions were successfully implemented, the program results indicated that the experimental group children showed nearly 25 percent more growth on verbal and quantitative achievement test scores than those in the comparison group. The intervention procedures are detailed and the full findings are presented in textual and graphical forms. (10 references) (DB)

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Native Hawaiian Hearing and Speech Project

Counteracting the Negative Educational Effects of Otitis Media in Native Hawaiian Preschoolers

Final Report
October 1991

EC 301168

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KAMEHAMEHA SCHOOLS / BERNICE PAUAHI BISHOP ESTATE

NATIVE HAWAIIAN HEARING AND SPEECH PROJECT

COUNTERACTING THE NEGATIVE EDUCATIONAL EFFECTS OF OTITIS MEDIA IN NATIVE HAWAIIAN PRESCHOOLERS

Grant HI33A90001, National Institute on Disability and Rehabilitation Research,
United States Department of Education

OCTOBER 1991

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B. Hearing and Speech Screening Medical Referral

C. Communication Screening Checklist

D. Speech Center Lesson Plans

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Note: Attachments are bound separately and will be supplied upon request.

CHAPTER I
The Project

The objective of this project was to produce a significant improvement in the educational achievement of Hawaiian preschool children within two years.

Earlier research (Heath, Plett, and Tibbetts, 1987) has shown that, (a) young Hawaiian children exhibit extremely poor performance on standardized tests of language skills, (b) these children are subject to a high incidence of moderate, intermittent hearing loss, and (c), there is a statistically significant relationship between these two phenomena.

Our hypothesis was that Kamehameha Schools could achieve a demonstrable improvement in the language competence of Hawaiian children by introducing an integrated six-component communication program into preschool classrooms. To test this hypothesis, the communication program was implemented in five preschool classes serving approximately 100 Hawaiian children.* Five parallel Kamehameha Schools/Bishop Estate (KS/BE) preschool classes (approximately 100 children) were monitored as a comparison group.

The six components of the experimental program were:

1. an enhanced hearing loss and middle-ear disorder screening and speech screening procedure,
2. a follow-up effort insuring every child who failed the screening received appropriate medical care,
3. the reduction of classroom ambient noise levels to an educationally-acceptable level as specified by an acoustic engineer,
4. the amplification of instructional speech to an educationally effective signal-to-noise ratio,
5. special communication-enhancing classroom teaching techniques, a classroom speech center, and equipment (electronic speech trainers) designed to improve the language competence of children experiencing moderate speech and hearing difficulties,
6. an individualized home and school communication therapy program for those children identified as most needful.

* It was originally proposed that the experimental group would include six classrooms. Due to the prolonged illness and eventual death of one of these six teachers, that classroom was dropped from the experimental group.

The first year (1989–90) of the project was used to employ and train new staff, acquire and introduce new equipment, to familiarize teachers and aides with the project components, and to pilot-test the interventions. Based on this pilot testing and consultation with teachers and aides, a number of modifications in the original components were made and at least one new procedure (the classroom Speech Center) was employed in the second, field-test, year (1990–91).

This report describes the procedures and presents the findings of the project.

CHAPTER II
Procedures

Preparation

Prior to the screening of children in Fall 1989 and Fall 1990, the project staff prepared teachers, parents, and children for the procedures that would be used. In a series of in-service sessions, teachers, aides, and other staff members of the Kamehameha Schools' Early Education Division (EED) were informed of the project objectives. The project members were introduced and their functions explained. Screening and service procedures were demonstrated, and questions and concerns were answered.

Similarly, at school-site orientation meetings, the project staff introduced the project and its goals to parents. During these meetings project staff explained the importance of speech and hearing in education, described the screening and follow-up procedures, and outlined the design of the project. Differences in services provided to experimental and comparison-group classes were detailed.

In the discussions following these presentations, some parents expressed concerns about the transportation of their children to the screening center, the difference in services provided to experimental and comparison groups, and anxieties their children might feel. In response, the parents were assured that pre-screening visits to the classrooms by project staff and other measures would be undertaken to allay the children's concerns. Also, the methodological necessity of a comparison group was explained.

Finally, the project staff visited each classroom to prepare the preschoolers for the screening experience. Prior to these visits, the teachers showed children photographs of project staff in various screening settings.

To prepare the children for the bus/car rides, the project audiologist and speech pathologist showed children slides of various landmarks the preschoolers would see en route to The Kamehameha Schools campus. A finger play was presented and the children were asked to follow along. Visual props of ears, mouths and hands were used to familiarize the children with the screening procedure and the responses that would be expected of them. Various pieces of hearing loss and middle-ear disorder screening equipment were shown and demonstrated. Children were encouraged to try on earphones and to handle an otoscope. Reminder letters were distributed to parents prior to each school's screening date.

Screening Procedures: Organization

The same screening procedures were followed for both Fall 1989 and Fall 1990. A total of 219 children were screened between August 24th and October 7th, 1989, and 217

children between August 30th and October 26, 1990. On the island of O'ahu the children were transported to the screening center located at The Kamehameha Schools' Early Education Division building. Each morning 10 children were transported from their school to the screening center by project personnel. Either the teacher or her aide accompanied the children. An aide provided by the project was available to substitute in the classrooms. At the screening center, project aides were present to assist in caring for the children.

When the children arrived at the screening center they were greeted at the door by project staff. They were then escorted to a room designated as the playroom. There, the children were given a snack and had the opportunity to familiarize themselves with the surroundings and with staff members. After this orientation, one child went with the audiologist, one with the speech pathologist, and one with the physician. The screening required 15 to 17 minutes per child.

Each of the testing rooms was identified with a picture outside its door. The audiologist's room had a picture of a smiling boy wearing earphones. The speech pathologist's room had a smiling girl looking at a book. The physician's room had a picture of a smiling physician holding an acoustic otoscope. The children's playroom had a picture of a clown holding balloons.

The children were routed through these rooms as they completed each component of the screening. During their wait, the children were attended by two aides. The aides read stories to the preschoolers. The children also colored, played with manipulatives and other toys, and went to the school's playground for physical recreation. Lunch was provided to those children who normally had lunch provided by their schools. All other children brought their own lunch.

On the two neighbor islands (Maui and Kaua'i) the children were transported to a medical clinic or doctor's office for hearing loss and middle-ear disorder screening. Testing booths were located at the Kaiser Permanente Clinic on Maui and at an otolaryngologist's office on Kaua'i. Children were transported five at a time by project personnel and were accompanied by either their teacher or aide. On both islands speech and language screening, as well as the otoscopic examination, was conducted at the preschool sites.

The screening conducted by this project included (a) collecting health history information, (b) a four-part hearing examination (otoscopy by a pediatrician, pure tone audiometry, immittance tympanometry, and acoustic reflectometry by a licensed audiologist), and (c) a speech and language screening by a licensed speech pathologist that included assessment of articulation, receptive and expressive language, communicative interaction, and several other communication-related attributes (fluency, voice, dental caries, and general hygiene).

Other data are routinely collected when children enter the KS/BE preschools. These data (demographic information and educational test scores) are used here to assess the comparability of the experimental and comparison-groups and to test the primary hypothesis of the project.

Hearing Loss and Middle-Ear Disorder Screening

Otoscopy: On O'ahu and Kaua'i, a pediatrician from the Kapiolani Medical Center for Women and Children was contracted through the Hawai'i State Department of Health (DOH) to conduct the otoscopic examinations. On Maui, a local pediatrician was contracted through the Department of Health to conduct otoscopic examinations. Otoscopic screening was performed using a pneumatic otoscope. An eight-point revised otitis media disease severity scale developed by Dever, Stewart and David (1985) was used to classify the appearance of the tympanic membrane. Either Class 1 or Class 2 was considered a "Pass" finding. Screening of Kaua'i and Maui children was conducted at those preschool sites. All other children were examined at the screening center.

Otoscopy Screening Categories
(Revised Otitis Media Disease Severity Scale)

Class	
1	Neutral, white, mobile normal, translucent
2	Neutral or slight retraction, white or pink, mobile or slight decrease, slight tympanosclerosis, slight opacity
3	Retracted, healed perforation, extensive tympanosclerosis, decreased mobility
4	Bulging, pink, grey, amber, red, decreased mobility
5	Severe retraction, marked decreased mobility
6	Perforation
7	Unable to visualize (wax, foreign body, refusal, other obstruction)
8	Foreign body
9	Missing

Class 1 is a normal tympanic membrane, Classes 2–3 connote past mild disease, and Classes 4–6 indicate active diseases requiring therapy.

Audiometry: The audiometric portion of the screening was conducted in a sound treated booth. Both the audiologist and the child were seated in the booth for the screening

procedure. The audiometric portion of the preschool-entry screening required about seven minutes.

Pure tone screening was conducted at a 15 decibel (dB) level at 500, 1000, 2000, and 4000 Hertz (Hz) on a Maico MA 39 portable audiometer. The American Speech and Hearing Association (ASHA) *Guidelines for Identification Audiometry* (ASHA, 1985) and *Guidelines for Screening Hearing Impairment and Middle-Ear Disorders* (ASHA, 1990) recommend a 20 dB screening level. However, since the project procedures were conducted in a sound treated booth, a more sensitive screening level of 15 dB was used. This permitted detection of mild hearing difficulties.

The ASHA 1985 Guidelines say:

> A basic assumption behind the guidelines is that identification audiometry is usually conducted in the relatively poor acoustic environments of schools and offices. Consequently, the procedures recommended are designed to be robust enough to be valid in a wide range of settings. Naturally, it would be desirable for all identification audiometry to be conducted in acoustic environments that are controlled, but such environments are seldom available (p. 50).

Most of the children screened were able to use the traditional hand raising response to the tonal stimuli. Conditioned play audiometry was used with a few students who did not respond appropriately.

This follows the ASHA 1990 Guidelines:

> Audiometric screening should be performed by the method described in the ASHA Guidelines for identification Audiometry (ASHA, 1985). Those guidelines recommend screening with pure-tone stimuli presented at 20 dB HL (re: ANSI S3.6–1969) with frequencies of 1000, 2000, and 4000 Hz. Failure to respond to any frequency constitutes failure of the audiometric screen. In accordance with the identification Audiometry Guidelines, failure of the audiometric screen should be confirmed by a rescreen, either on-site or by additional testing at a later date. If the audiometric screen is failed on the second administration, a complete audiologic evaluation should be performed. (p. 22)

Tympanometry: A Grason-Stadler GSI28A Auto Tympanometer was used to conduct immittance measurements. Air pressure was systematically varied in the hermetically sealed ear canals of the children and the pressure-compliance function of the ear was recorded along with measures of static admittance, ear canal volume and acoustic reflexes at 1000 Hz.

For the Fall 1989 screening, resting pressure readings outside of the –200 to +100 range, as well as any reading of NP (no pressure) were considered failures, as recommended by

ASHA's *Guidelines for Acoustic Immittance Screening of Middle-Ear Function* (ASHA, 1979). Acoustic reflex results were not used in determining pass/fail as reflex guidelines were being revised by ASHA.

New guidelines for tympanometry were issued in *Guidelines for Screening for Hearing Impairment and Middle-Ear Disorders*, (ASHA, 1990). In accordance with these new guidelines, static admittance (Peak Y), and tympanometric width (TW) were used to determine Fall 1990 pass/fail status. Any readings of static admittance less than 0.2 cm^3 or tympanometric width greater than 150 daPa were considered to be failures.

Changes in the ASHA Guidelines (1985 to 1990) served to reduce the number of children failing the tympanometric screening in the second project year (1990) from levels in the 1989 school year. This was the intent of new Guidelines:

> Recent studies of the effectiveness of recommended medical criteria from tympanometric results have demonstrated that excessive over-referral rates occur when the referral is based on the existence of abnormal tympanometric findings alone... To avoid the excessive over-referral rates that characterize screening protocols that are based solely on tympanometry, the screening protocol described in these guidelines includes four sources of data: history, visual inspection, identification audiometry, and tympanometry. (p. 18)

Acoustic Reflectometry: Acoustic reflectometry is a screening procedure for identifying the presence of middle ear fluid. It is performed with an instrument called an acoustic otoscope. The acoustic otoscope generates a 100 msec 80 dB SPL tone which modulates between 2000–4500 Hz. The tone is directed into the ear canal and the magnitude of the reflected signal off the eardrum provides an indication of presence/absence of middle ear fluid. As recommended by the manufacturer, ENT Medical Devices, Inc., reflectivity readings of zero to five were considered normal and readings of six to nine suggested the presence of middle ear fluid. The comparative results of reflectometry and other screening techniques are given in Figure 1. Published reports regarding the effectiveness of acoustic reflectometry have been mixed.

For both Fall 1989 and Fall 1990 screenings, failure of any one part of the screening resulted in a medical referral or a referral for a diagnostic audiological evaluation. Children in the experimental classes who had failed a part of the exam received a clinical audiological evaluation provided by the project at the screening center, while children in comparison-group classrooms were referred to their family doctors for follow-up care. The audiological evaluation included pure tone air and bone conduction threshold tests, speech audiometry and immittance audiometry. Medical referrals were made for children in experimental classes following the clinical audiological evaluation if needed. Physicians were provided the results of the clinical audiological evaluation.

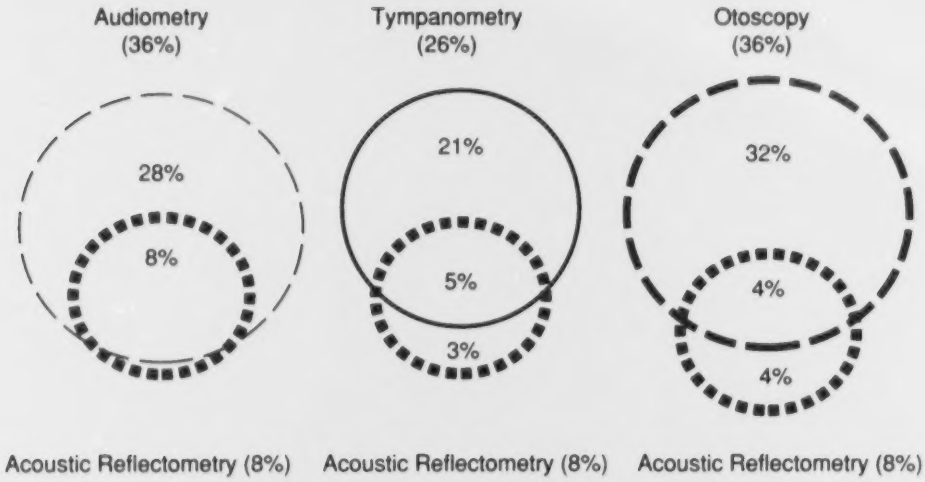


Figure 1. Congruence of Acoustic Reflectometry Findings (Fail) with Other Screening Methods, Fall 1990: Experimental and Comparison Groups Combined (N=171)

In addition to the individual pass/fail results for each screening method, a "Summary Status" indicator was created. The "Summary Status" provides an overall picture of a child's hearing and middle ear disorder screening results, and is based on the results of audiometry, tympanometry and otoscopy. If a child passed all three screening methods, the child's "Summary Status" was "Pass." If a child passed the audiometry but failed either the tympanometry or the otoscopy, the child's "Summary Status" was "Possible Problem." If a child failed the audiometry or failed both the tympanometry and otoscopy, the child's "Summary Status" was "Fail." The audiometry result was weighted more heavily than the other two methods since it directly measures the child's ability to hear.

Hearing Screening: Summary Status Variable

(Based on Audiometry, Tympanometry and Otoscopy Results)

Audiometry	Tympanometry	Otoscopy	Summary Status
Pass	Pass	Pass	Pass
Pass	Fail	Pass	Possible Problem
Pass	Pass	Fail	Possible Problem
Fail	Fail	Fail	Fail
Fail	Fail	Pass	Fail
Fail	Pass	Fail	Fail
Pass	Fail	Fail	Fail
Fail	Pass	Pass	Fail
Any one of the three tests missing			Missing

Periodic Hearing Loss and Middle-Ear Disorder Screening

Following the initial fall screening, all subsequent rescreenings were done at preschool sites. Rescreening dates were scheduled approximately three weeks apart. Teachers were consulted as to dates of field trips and other special classroom activities before the screening was scheduled. The availability of a testing room was also considered when scheduling a screening date. During the 1989–90 school year, seven screening cycles were completed between November 6, 1989, and May 7, 1990, with a total of 718 screenings conducted. During the 1990–91 school year, six screening cycles were completed between November 2, 1990, and April 1, 1991, with a total of 619 screenings conducted.

Each screening cycle was preceded by a measurement of ambient noise levels. A Quest model 155–145 precision sound level meter and octave band analyzer were used to measure octave band sound pressure levels at each of the test sites. The background octave band SPL's at 500 Hz nearly always exceeded the permissible level for screening at 20 dB. The level at 1000 Hz frequently exceeded permissible levels at certain schools. The levels at 2000 and 4000 Hz were always within acceptable limits. The permissible octave-band sound pressure levels were in accordance with the 1985 ASHA Guidelines.

Audiometry: Pure tone screenings were conducted away from the classroom, in a quieter room of the school, using a Maico MA 39 Portable Audiometer. Two or three children were escorted to the testing room at one time.

A screening level of 20 dB was used at 500, 1000, 2000 and 4000 Hz. Thresholds were obtained if there was no response to 20 dB at any frequency. Although responses at 500 Hz were obtained, they were not considered when determining failures.

These were the criteria that were used:

1. Failure was defined as no response to 20 dB at 1000 Hz if tympanometry or acoustic reflectometry were failed. However, due to fluctuating noise levels at 1000 Hz, thresholds of 25 dB were accepted if tympanometry and acoustic reflectometry were within normal limits.

2. Failure was defined as no response to 20 dB at 2000 or 4000 Hz in either ear. Children who failed the pure tone screening were referred for a diagnostic evaluation if they had not already had one. A medical examination was recommended if the diagnostic evaluation results indicated a need. Immediate medical referrals were made if the child failed either tympanometry or reflectometry at the time of the screening.

The new criteria established for periodic screening in the 1990–91 school year were as follows:

1. Failure was defined as no response to 20 dB at any one frequency and abnormal tympanometric or reflectometry measurements. These children were referred for a medical examination and a diagnostic evaluation if the evaluation had not previously been done following the Fall screening.
2. Failure was defined as no response at 20 dB at any two frequencies and normal tympanometric and reflectometry results. Diagnostic evaluations were recommended for these screenings. Medical referrals were made unless these were chronic, permanent conditions.
3. Failure was defined as no response at 20 dB at any one frequency for two successive screenings. Diagnostic evaluations were recommended for these children. Medical referrals were made if the evaluation results indicated a need.

Tympanometry: A Grason-Stadler GSI 28A Auto Tympanometer was used to conduct tympanometry in the classroom. The instrument was set up in a corner of the room and the children were called one at a time from their various work centers. Middle ear pressure (resting pressure), tympanometric shapes and acoustic reflexes at 1000 Hz were automatically recorded.

During the 1989–90 school year failure was defined as resting pressure readings outside the –200 to +100 range and any readings of NP (no peak). As in the fall screening, acoustic reflexes were not considered when determining failures. All children who failed were referred to their family physicians for medical examination.

In the 1990–91 school year tympanometric failures also resulted in recommendations for medical examination. The Fall screening criteria were used.

Acoustic Reflectometry: Reflectometry was conducted directly after tympanometry. The ENT Medical Devices, Inc., acoustic otoscope was used.

Reflectivity readings of 6 to 9 were considered failures. Children who failed on this screening method and either one of the other two screening methods were referred to their family physician. However, a few cases were not referred because these were chronic middle ear conditions and were already being monitored by their physician.

Immediately after each screening teachers were informed of the children who failed. The teacher's attention was directed especially to those children failing the audiometric screening, which is an indication of hearing loss.

Parents or guardians were notified of the results within seven days of the screening. They were provided with a copy of the screening results, a form letter indicating pass/fail

status, (Attachment A) and if necessary the need for an audiological evaluation or for medical attention. Medical referral report forms (Attachment B) were attached to the letters to parents advising medical follow-up. The report forms were to be completed by the physician and returned to project staff. As a reminder, notes were also sent to parents urging them to seek medical or audiological diagnostic examinations, or to continue medical follow-up.

In addition to these periodic screenings, teachers were asked to conduct acoustic reflectometry on any child they suspected of having hearing loss. Acoustic otoscopes were placed in each of the five experimental classrooms. Teachers and aides were trained in the use of the acoustic otoscope and informed of signs to observe for hearing loss. They were advised to refer failures to the audiologist. However, knowing the children were periodically screened by the audiologist, teachers could not be persuaded to use the acoustic otoscope provided with much frequency.

To encourage appropriate medical care, parents and guardians were often contacted in the classroom or by telephone. The public health nurse and audiologist used these contacts to explain and remind caregivers of the need for medical care when medical referral reports were not returned to project staff by the family physician within a four to six week period. The public health nurse also offered assistance with transportation if this was a problem.

During the 1989–90 school year, the audiologist returned to each of the five experimental classrooms between screening cycles to monitor children with possible hearing loss. These visits were also used to assist teachers in the use of amplification equipment, to take noise level readings in the classroom, and to conduct parent workshops. These visits also provided an opportunity for playing simple listening games with small groups of children in one of the classroom work centers. In this center the children played games that were designed to improve listening skills. Some of these games involved listening to taped household sounds such as a telephone ringing, vacuum cleaner running, etc., naming the sound and describing the item's function. Other games involved selecting pictures after listening to verbal descriptions, or retelling a portion of a taped story. The listening games were approximately 10–15 minutes in length.

Speech Screening

The speech screening conducted by a licensed speech pathologist evaluated three major aspects of communicative functioning. These were articulation, language and communicative interaction. The articulation and language portions of the screening were completed either at the screening center or at the preschool site. Test administration averaged nine minutes per child.

To establish rapport between the tester and the child, the child was given a box containing a variety of small toys to play with. Toys included a telephone, McDonald's

Transformer toys (hamburger, milk shake, french fries), a walking soccer ball, racing cars, dinosaurs, a doll, bubbles, and tiny story books. These toys were used to elicit utterances from the children. The first 10 utterances were recorded. This language sample was used to rate the child's syntactical abilities on a scale of 1 to 3. If the majority of the child's utterances were incomplete phrases, a rating of "1" was given; a rating of "2" was given for simple sentence structures; and a rating of "3" for productions of compound or complex sentences. In addition, the language sample was used to rate the child's communicative intent. If the child merely labelled the toy, a rating of "1" was given. A rating of "2" was given for providing descriptions of the toys; and a rating of "3" was given if the child asked questions or was able to relate immediate or past experiences. The number of words spoken in the longest utterance was also recorded.

After obtaining the language sample, the *Van Riper Predictive Screening Test of Articulation* (Van Riper and Erickson, 1970) was given. This screening test consists of 47 items which were developed to discriminate between those children who could master their misarticulations without speech therapy from those who, without therapy, would persist in their errors. Also included in the articulation screening was a brief assessment of the speech musculature, i.e., an oral peripheral examination to look at the tongue, lip and jaw mobility and coordination as it related to speech-sound production. Dentition was also examined for the presence of cavities and missing teeth.

Throughout the screening session, vocal quality and fluency of speech was judged and ratings of "adequate" or "not adequate" were given. The presence of any hoarseness or stuttered speech was also noted.

Following the articulation screening, more language portions of the screening were administered. Items were selected from the *Sequenced Inventory of Communication Development* (SICD) Revised Edition (Hendrick, Prather, and Tobin, 1984). The SICD is a diagnostic test commonly used by speech pathologists to evaluate the communication abilities of children who are functioning between four months and four years of age. SICD items such as those requiring following three-step, two-step, and two-object commands and following directions with the prepositions, "in", "on," "under," and "beside" were selected. These items represented the receptive portion of the screening. Expressive language ability items included two single-sentence repetitions and answering a series of "what" and "how" questions.

The total number of correct items were counted separately for the articulation and language portions and were assigned ratings of the following: "1–acceptable," "2–retest in 8 months," "3–retest in 4 months," "4–diagnostic evaluation required" or "5–refer for medical follow-up."

For the communicative interaction portion of the screening, teachers were asked to complete a *Communication Screening Checklist* (Attachment C). This screening checklist is based on items developed by staff at the Experimental Educational Unit of the Child Development and Mental Retardation Center at the University of Washington's College of Education. Teachers were asked to rate each child's verbal initiating and responding behaviors and to note any concerns relating to articulation, language, communication or behavior problems. Each of the behaviors was rated with "always," "sometimes," or "never." Teachers were given the checklist in the middle of September and were asked to return it by the first week of October. This gave the teachers an opportunity to observe each child before assigning ratings. Upon return of the checklist, the speech pathologist assigned overall ratings of "1–acceptable," "2–retest in 8 months," "3–retest in 4 months" or "4–diagnostic evaluation." Guidelines for the scoring procedures were developed by the project's speech pathologist.

An item on general personal hygiene was also included on this checklist. Teachers were asked to rate the child's overall daily appearance on a scale from "1" (clean) to "5" (unkempt).

Speech screening failure was based on the ratings given for articulation, language, voice, fluency and communicative interaction. Recommendations for a recheck in four or eight months, diagnostic evaluation or no follow-up were made.

Speech and Language Therapy Procedures

During the 1989–90 and 1990–91 school years, speech and language therapy services were provided to children in the five experimental classrooms.

In the 1989–90 school year speech services were provided to all 20 of the children in three of the five classrooms by the project speech pathologist. These classrooms were at Nanakuli, Nanaikapono and Ma'ili (1) sites. In these three classes, service was geared toward improving the children's use of syntactically correct structures of Standard English, improving expressive vocabulary skills and facilitating communicative interaction skills among peers. These objectives were accomplished in small language group settings, on a one-to-one basis and during block and home center time. In the small language group settings, the specific activities included expressive vocabulary naming tasks and verbalizing sentences with plurals, past tense, prepositional and adjective phrases using picture cards. With one-to-one assistance, the use of Standard English sentences was modeled and corrected using photo narrative dictation activities. During block and home center time, Standard English sentences and correct speech sound productions of words were modeled. In addition, in these classrooms individualized speech and language therapy services were provided to specific children who needed extra assistance with their speech and language

skills. At the Kahuku and Ma'ili (2) classrooms, only individualized speech and language therapy services were provided.

In the 1990–91 school year, in addition to the individualized therapy programs, speech-language services were provided to all children in the five experimental classrooms via the Speech Center, described later in this report.

Selection for Individualized Therapy: Children taking the initial speech screening were assigned overall ratings of "1–acceptable," "2–retest in 8 months," "3–retest in 4 months," "4–diagnostic evaluation," or "5–medical referral." Those children who received ratings of "4" were given a complete speech and language test battery.

In addition to administering a complete speech and language test battery, a diagnostic report was produced. The report included several components. Background information was first obtained regarding the school's and family's concerns about the child's speech and language skills. Developmental milestones were obtained from the health history information collected and an interview with a family member, usually the mother, was conducted to obtain further information regarding the stated speech and language problems. Next, behavioral observations of the child were made in the classroom setting to observe speech and language behaviors and communicative interaction skills. An interpretation of information from the *Communication Screening Checklist* was also included. This checklist, which was completed by the classroom teacher, was used to describe each child's initiating and responding behaviors. Following this information gathering process, each child was tested. Tests administered included the *Goldman Fristoe Test of Articulation* (Goldman and Fristoe, 1986), the *Sequenced Inventory of Communication Development* (Hendrick, Prather, and Tobin, 1984), and an oral peripheral examination. Information regarding the child's hearing acuity was obtained from the hearing loss and middle-ear disorder screening completed by the audiologist.

Based on the diagnostic report, an individualized plan for speech and language therapy was developed. Individualized programs, with specific objectives and a summary level of performance, were developed for each of the child's individual needs for remediation. The appropriateness of the objectives was discussed with the classroom teacher, site manager and parent. Progress with each specific objective was charted on the speech-language therapy contact log. Progress was marked as "1–no progress, "2–progressing," or "3–mastered." In addition, pre- and post-baseline measures as to the level of accuracy of performance were taken for each objective. For example, the ability to produce the /k/ sound in words at pre-baseline was 20%, post-baseline measures were seen at 75% level of accuracy. The data were obtained from speech tests and language samples the speech pathologist kept as part of each child's log of activities.

Frequency of Therapy Services: Children were seen individually and/or in small group settings once a week at the school site. Parent participation although not mandatory, was highly recommended. Only one parent declined to participate in a home program. The parent stated she would not be able to follow through at home as she had other priorities in her life. Parents were initially seen once a week; later, depending on their child's progress, sessions were decreased to biweekly or monthly as appropriate.

During the 1989–90 school year individualized speech and language therapy services were provided to a total of 27 children (27% of the 100 children in the experimental group) and their families in the five experimental classrooms. These children were identified as being in need of extra speech and language assistance based on the fall speech screening results. Most of the speech therapy work during the first year involved individualized home and school programs.

During 1990–91, with the implementation of the Speech Center, all the children were seen in small groups twice a week by a project staff member. The 29 children who received individualized speech-language therapy were seen at least once a week by the speech pathologist.

Individual Therapy Sessions: Individual therapy sessions involved work not only with the child but also with parents and teachers as well. Initially each child was seen individually to determine the present level of success and to determine which therapeutic strategies would be most beneficial. In most cases the child was integrated into small language group therapy sessions. The purpose of this integration was to facilitate the generalization of newly learned language and/or articulation skills.

Parents participated in individual therapy sessions as well as parent workshops at each experimental site. The initial work was directed toward increasing their understanding of their child's speech and language problem and making them aware that with therapeutic assistance, improvements could be made. Speech and language correction techniques and strategies specific to their child's problem were demonstrated to the parent or family member participating in individual sessions. Specific home assignments on these techniques were given to the parents on a weekly basis. Packets of materials for home assignments were developed for each child seen for therapy. In addition, these parents received information at the parent workshops about the effects of ear infections on speech and language acquisition, and general language stimulation techniques.

Teachers were informed weekly of the child's progress. They sat in on therapy sessions, were shown specific therapeutic corrections techniques and were given feedback regarding home progress as reported by family members. Teachers were also asked to report regularly to the speech pathologist about the child's performance in the classroom. Based on these teacher reports and the child's therapeutic progress, appropriate adjustments were made to the child's program.

Table 1 provides information on the type of speech therapy services provided. In the 1989–90 school year a total of eight children were "Hot Line" referrals. Table 1 displays the percent of these children referred and the reason for referral. These referrals were made by teachers after the initial speech screening identification process had been completed. Four children were referred for language, two for articulation, and two for attending behaviors.

The severity of the speech and language problems for the 27 (1989–90) children, on the whole, were rated to be mild to moderate in nature. Only four cases were rated to be of a severe nature. Two of these cases involved language disorders, and the third was an articulation disorder. The fourth case was related to a bilateral severe high frequency hearing loss.

Table 1. Percent of Children Receiving Speech/Language Therapy Services, Hot Line Referrals and Individual Student and Parent Contacts, 1989–90 and 1990–91 School Years

	Speech/Language Therapy		Hot Line Referrals	
	1989 (N=27)	**1990** (N=29)	**1989** (N=8)	**1990** (N=0)
	%	%	%	%
Articulation	37.0	48.3	25.0	–
Language	33.3	41.4	50.0	–
Voice	3.7	–	–	–
Fluency	–	6.9	–	–
Communication	7.4	–	25.0	–
Multiple	18.5	3.4	–	–

	Individual Student and Parent Contacts	
	1989 N	**1990** N
Student Contacts	292	183
Parent Contacts	191	67
Ratio of Parent to Student Contacts	65.4	36.6

The total number of contacts made with individual students in all five experimental classrooms was 292 for the 1989–90 school year. The total number of parent contacts was

191. Table 1 presents the number of individual student and parent contacts. Because of the work being done in the Speech Centers, this kind of parent contact was considerably less frequent in the second year.

During the 1990–91 school year, individualized speech and language therapy services were also provided. The same criteria used to select students for speech-language therapy services in 1989–90 was used for 1990–91. Diagnostic reports and individualized therapy programs, described previously, were developed for each child. Speech-language therapy services were provided to a total of 29 children and their families in the five experimental classrooms. Of the 29 children, 14 children (48.3%) were seen for articulation therapy, 12 children (41.4%) for language therapy, 2 children (6.9%) for fluency, and 1 child (3.4%) for multiple (articulation and language) problems. Compared to the previous school year, the number of children seen for articulation and language therapy in 1990–91 increased by just a little more than one-third over the previous school year. Table 1 shows the percent of children receiving therapy services.

The severity of the speech and language problems for the 29 (1990–91) children ranged from mild to severe. Only three cases were identified as severe. One case was an articulation disorder, one was a language case, and the third involved a problem of both articulation and language.

There were no "Hot Line" referrals (Table 1) made during the 1990–91 school year. It appears that the children with special needs were identified from the fall screening and by the teacher observations.

Teaching Techniques: In addition to the individualized therapy sessions, the speech pathologist worked with the five experimental teachers on the use of special communication-enhancing techniques in the classroom.

One of the communication-enhancing teaching techniques involved the introduction of the Loquitur, an electronic speech training device. Introduced into the classrooms in January and February of 1990, The Loquitur is a therapeutic device that provides children with immediate auditory feedback for articulation, language and voice training. The Loquitur was used in a variety of ways in the classroom. The teachers devised techniques of their own to use it to meet their curriculum objectives. These included providing immediate auditory feedback of a child's verbalizations during sharing time, modeling and listening to Standard English sentence structures, practicing the recitation of nursery rhymes, following three-and four-step oral commands, and encouraging conversational exchanges between peers. Parents were involved in the use of the Loquitur in school and at home. At the Ma'ili and Nanakuli sites, parents came to the school regularly to carry out individually developed therapeutic programs for children with speech and language problems. Parents were taught to have their child listen to and practice Standard English sentences. The sentences modeled were related to the class activities for the day or week.

The Loquitur was also available for use at home. One parent from Nanakuli borrowed it for the weekends.

Another special teaching technique was the use of manual hand signs taken from the American Sign Language. Individual hand signs for the letters of the alphabet were used to facilitate correct speech sound productions and to reinforce the use of "s" in plural endings. To encourage complete sentence production and the use of correct syntactical structures, signs for words such as "I", "this", "is", and "am" were used. In addition, hand signs were used to facilitate success in following two-and three-step directions. Hand signs also provided visual cues so a child could answer questions correctly.

Other teaching techniques included the use of kinesthetic cues and an exaggerated voice to emphasize the production of correct speech sounds. Kinesthetic cues allowed the child to feel the production of the sound as it is being said. For example, the child could feel the air of the /p/ sound on the back of his hand as it is being produced by the adult. The use of an exaggerated voice by the adult added heightened awareness of corrected production of misarticulated sounds for the child.

Speech Center 1990–91

In addition to individualized therapy programs, speech-language services were provided to all children in the five experimental classrooms. Through a model called the Speech Center, language stimulation and vocabulary enrichment activities were delivered to the children.

The rationale to provide services to all the children was based on findings from the standardized test results and observations made during the 1989–90 school year. It has been documented that young Hawaiian children demonstrate extremely poor performance on standardized tests of language skills. The average score on the *Peabody Picture Vocabulary Test-Revised* (PPVT-R) (Dunn and Dunn, 1981) for ethnic Hawaiian children entering kindergarten statewide and for KS/BE preschoolers is at the 10th percentile on national student norms (Figure 2). This pattern of achievement test scores has been observed over the last six years (Figure 3). We learned from observation in the classroom, that most of the children demonstrate weaknesses with verbal labeling skills, in using Standard English structures, and in understanding sequential instructions. Consequently, we believed that all of the children in the experimental classrooms should receive speech and language services. After brainstorming sessions with teachers and site managers on ways to improve our service delivery program we developed and implemented a new intervention—the Speech Center. To implement the Speech Center, scheduling and program procedures were initially discussed with classroom teachers, aides and site managers. A master schedule of service delivery dates was then given to site managers and teachers to review.

See Figure 2 errata page 80.

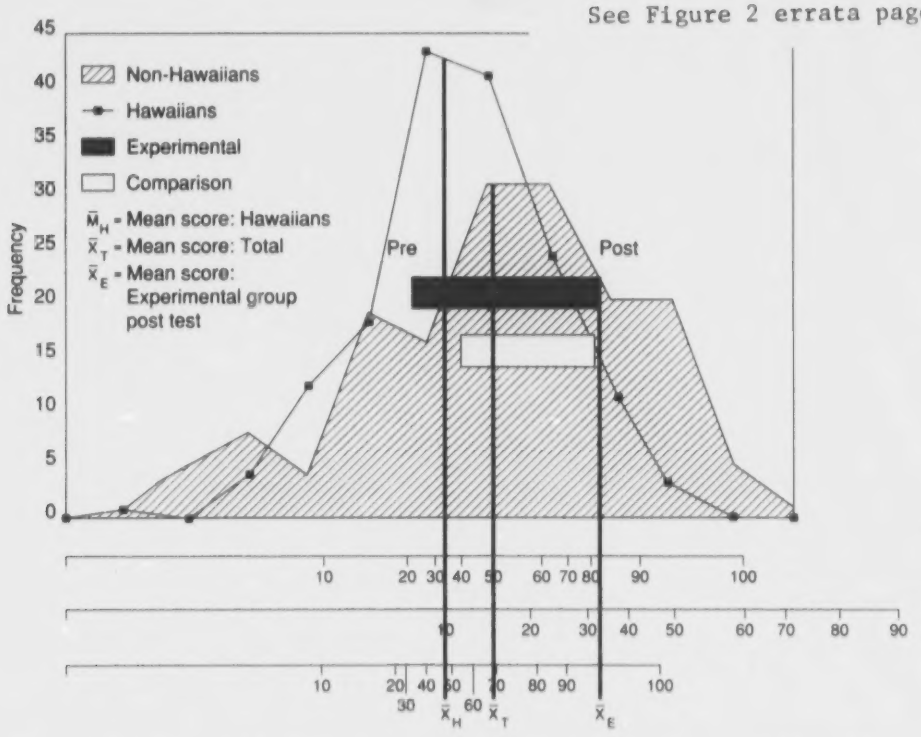


Figure 2. Statewide Entering Kindergarten Hawaiian and Non-Hawaiian Children (1989–90); Experimental and Comparison Group Growth in PPVT-R (Vocabulary) Scores, 1990–91

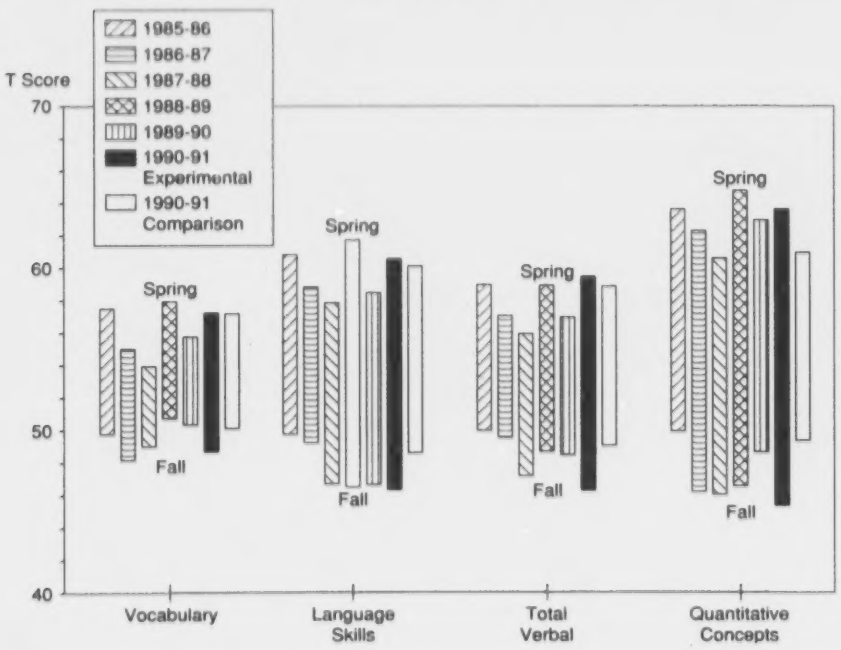


Figure 3. Preschool Test Results, 1985–86 through 1990–91

Working cooperatively with the classroom teachers was a major focus of the Speech Center. To accomplish this we asked for the teachers' cooperation in assigning a work center twice each week to Hearing project staff. (The classes are organized into several "centers" during most of the school day.) A project staff member directed speech-language and listening development activities in the center. Children were seen in groups of four to seven at a time in the Speech Center. The groups rotated through this Center every 15 to 20 minutes, depending upon the teacher's daily schedule.

The speech pathologist trained project staff members to work in the Speech Centers. For two weeks, the audiologist and research assistant observed and participated in Speech Center activities conducted by the speech pathologist in each of the five experimental classrooms. An integral part of the training included demonstrations and discussions of speech-language therapy principles and techniques.

Individualized Speech Center lesson plans were developed for each classroom by the speech pathologist. Lesson plans were customized for each of the classrooms as the Fall 1990 speech screening results revealed a wide range of language abilities. In addition, lesson plans were developed around current classroom themes and activities. A lesson kit was developed for each classroom. This kit contained the current lesson plan and the materials needed for the Center's activities.

The format of each lesson plan included the following: 1) warmup activities, 2) listening activities, 3) vocabulary activities, and 4) rhymes. The lessons were hierarchial in nature ranging from simple to complex skills based upon the abilities and performance levels of the children in the classroom.

The warmup activities served several purposes. Gross and fine motor activities were used to help focus the children's attention. These activities also helped to reinforce body parts vocabulary, and to encourage the use of Standard English structures, such as the use of present and past tense verbs. Sample lesson plans are given in Attachment D.

The listening games included various activities such as identifying common environmental sounds, listening for key words and following directions. The children listened for directions given in a sequence, directions involving singular and plural words, and directions involving positional words.

The vocabulary activities focused on current classroom vocabulary. Teachers provided key vocabulary words and concepts which had been introduced to the children. These words and concepts were incorporated into the Speech Center lesson and served to reinforce daily classroom instruction. In addition, other new and related words were introduced. Activities for this section included three types of games, i.e., referential communication games, concentration games and oral expression games. Detailed descriptions and examples of these games were compiled into a Speech Center Guidebook

(Attachment E). This guidebook served as a reference manual for teachers and support personnel. The session usually ended with a rhyme that was related to the lesson's theme. The rhymes were created for each lesson and reinforced the key vocabulary and concepts for the lesson.

Both commercially purchased as well as handcrafted materials were used in the Speech Center activities. Common everyday items ranging from toilet paper rolls to empty juice containers were used to create innovative, unique and motivating materials. In addition, photos were taken of the surrounding communities and local landmarks familiar to the children and their families. These photos were used to stimulate and develop vocabulary and expressive language skills. The photos were enlarged to serve as a photo lending library for the parents. Staff members including the speech pathologist, the audiologist, the research assistant and the clerical staff all contributed to producing the materials. Classroom staff and parent activities were developed to promote the generalization of children's newly learned language skills. For example, one of the parent activities was focused on the consistent use of the Loquitur in which parents prompted the children to produce Standard English structures.

A minimum of two weekly contacts was scheduled for each of the five classes. Services were provided from December 1990 to April 1991. Staff members, i.e., the speech pathologist, the audiologist, and research assistant, rotated among the classrooms to operate these centers. During the month of March 1991 additional personnel were hired for the Speech Centers. An additional research assistant was assigned to four of the classes. A parent was hired for the Kahuku classroom. The total number of contacts for each of the classrooms ranged from 21 to 23 sessions except for Kahuku. The Kahuku classroom received 29 contacts.

Health History and Follow-up Efforts

Health History: In the Fall of 1989, the project's public health nurse conducted person-to-person interviews with 150 parents and/or primary care-givers at the seven preschool sites on O'ahu, Maui and Kaua'i. Telephone interviews were conducted with 69 parents and/or primary care-givers who could not be scheduled for "in-person" interviews.

Interview schedules were arranged with site managers and coincided with the pretesting schedules for each site. Pretesting dates provided an ideal time to meet with parents since they needed to accompany their children to the school sites prior to school entry. Because of a conflict in schedules, interviews at the Maui site were scheduled to follow the otoscopic screening.

Although many of the questions in the 1989 Health History Interview required a recall of detailed and personal information from up to four years, respondents made a serious effort

to provide complete answers. When information was obtained from care-givers other than the natural parents, every effort was made to corroborate information by telephoning the parents.

After reviewing the health history information collected in Fall 1989, an abbreviated revised questionnaire was developed for use in Fall 1990. This questionnaire was included in the preschool registration packets sent home to parents. (Health History questionnaire included as Attachment F.) Parents were asked to complete the questionnaire and return it when they brought their child in for pretesting. As project staff collected the questionnaires, the forms were reviewed for completeness. If necessary, parents were asked to provide missing data or to clarify responses. A total of 222 parents completed and returned the questionnaire.

Follow-up Efforts: The public health nurse, employed half-time, coordinated a multi-disciplinary effort ensuring that the children with identified, referable hearing losses and medical conditions received the appropriate follow-up and care. Parents were the primary focus of the efforts in assuring timely medical attention for the children. Other family members and care-givers as well as medical care providers, community health personnel, preschool teachers, aides and site managers, project staff and other community services agencies were also involved.

The primary method of contact was by telephone and in person interviews. Though telephone follow-up is usually a most time efficient method, the reality is that there were many barriers to overcome. These barriers included frequent phone service disconnections and number changes, no answer to calls, no return calls to messages left and receiving incomplete information. This necessitated a dogged approach to follow-up involving many persons and agencies who could provide the needed information and service. The ultimate goal was not harassment of parents, but the educational, physical and social welfare and well-being of the child. Most of the personal contacts with parents and child care-givers were accomplished by meeting them at preschool sites during the monthly parent workshops. This was an opportune time and place to meet as many parents as possible in a non-threatening environment. The public health nurse was able to give and get pertinent information and encourage and support parents in their concern and care of their children. Teachers, teacher aides and site managers were an invaluable source of information and support. Their knowledge about the family and willingness to facilitate follow-up efforts by the public health nurse were key in obtaining the desired outcomes in many of the children.

Follow-up with medical care providers could have been a relatively simple process of confirming verbal information received from parents. However, for whatever reason they may have had, some parents would say that their child was seen by their doctor and receiving necessary treatment, when in fact the child had not been seen, sometimes, in

many months. This, understandably, necessitated many more calls and contacts with family and others.

In addition, reports were sometimes received from medical care providers which required further clarification and completion. In some cases, it was necessary to request consents for release of information from parents to receive information on medical referrals initially made by the project. This happened because the providers did not receive the doctor's report form when the child was brought in for treatment. In the first year of the project, the public health nurse even made visits to clinic sites to pick up medical report forms which had not been returned.

The district public health nurses were a valuable resource to our follow-up efforts. Many of the children and their families were already receiving services from the district public health nurses. The project public health nurse contacted these public health nurses to advise them of the status of referrals made by our staff. The district public health nurses would then work with parents and care-givers to support and reinforce recommendations made by project personnel and medical care providers. Together, project staff and public health nurses obtained specialized medical care services as needed. Referrals were then made to district public health nurses in instances where on-going supervision would be most appropriate.

The public health nurse worked closely with the audiologist and speech pathologist who were in the classrooms at least once a week. These staff members assisted the public health nurse in encouraging parents to follow through on medical referrals and in helping them to obtain desired information about available resources and services. It was also necessary, in many cases, to work with other health and human service agencies within the community to ensure that the families were directed to the help they sought or needed. Follow-up was sometimes frustrating. It was baffling to be told that children had received medical care when in fact they had not.

Most of the families were covered under some sort of medical insurance and did not require this kind of help. However, there were several instances where medical coverage ceased due to a change in work status of the "primary insured". In most cases this was a temporary situation soon remedied by a resumption of employment and coverage. Where appropriate, referrals were made to other agencies, i.e. Department of Human Services for Medicaid assistance, Department of Health Children With Special Health Needs Branch for specialized otological services, Kapiolani Women's and Children's Medical Center Communication Disorders Clinic for audiological and otological services. In only one instance, in grant year 1989–1990, did it become necessary to provide unmet otologic services. As previously mentioned, some families were already receiving Medicaid or other specialized health and social services. This necessitated maintaining a link among all concerned parties so that the child did not get lost in the shuffle.

Public transportation is adequate on the island of O'ahu and most families were equipped with automobiles or had friends and other family members willing to transport them to doctors and clinics. Therefore, lack of transportation did not seem to be a major factor in whether children did or did not receive medical services. Transportation services, provided for through the grant, were offered to one family who, upon persistent prodding, admitted to not having access to ready transportation to a specialist's office in town. Surprisingly, this service was refused by the family who insisted that the family automobile would be repaired very shortly and the matter would be resolved. Although the child did subsequently get to the doctor's office, this only occurred after repeated offers, queries and gentle persuasion by the public health nurse and project staff.

One of the most common reasons for not seeking medical attention seemed to be that the child passed subsequent hearing loss and middle-ear disorder screenings. As noted in other parts of this report, periodic screenings took place approximately every three weeks. This time span was not sufficient to allow many families to make medical appointments, institute proper treatment and permit resolution of an acute or chronic ear infection which often could take weeks and even months. It was difficult at best, and usually impossible, to convince families to take a child who no longer showed signs of a suspected hearing problem or middle ear disturbance to the doctor.

Perhaps, because a mild ear infection or hearing loss is really a *silent* and often chronic condition, there was a tendency for families to put off attending to referrals. An even more common situation was the lack of on-going follow up with the medical care providers. Once the acute symptoms, i.e., pain and fever, subsided and the child appeared to be functioning as before, there did not seem to be an urgent need to continue with medication and return to the doctor as advised.

It appeared that the parents and care-givers who participated actively in parent education workshops were more likely to follow through on medical referrals and recommendations for follow-up. (At these workshops, staff regularly emphasized the relationship between ear infections and hearing loss resulting in delayed speech/language development and learning progress.) However, many of the parents whose children were experiencing some of these problems did not attend the workshops. In some cases, even an immediate positive response by the child, e.g., improvement in attending behavior following use of corrective hearing aids, did not mean that the family continued with the recommended treatment and therapy. Follow-up requires a cooperative effort among all parties concerned, i.e., parents and other child care-givers, teachers, medical care providers, other social and health services providers.

Parent Workshops

During the 1989–90 school year, 16 parent workshops were held for the five experimental classes. The Ma'ili site held five workshops; Nanaikapono and Kahuku held four each, and Nanakuli held three. A summary of the types of parent workshops is given in Table 2. The number of workshops presented at each site were dependent on the teacher's requests and other scheduling factors.

Table 2. Number of Parent Workshops by Type and Percent of Families Participating in the Workshops, 1989–90 and 1990–91 School Years

Type of Workshop	1989–90	1990–91
Informational	6	8
Interactive	1	–
Combined	9	16
Total	16	24
Percent of Families Participating	73	83

In the 1990–91 school year, monthly parent workshops were scheduled for the five experimental classrooms. A total of 24 workshops, six per site, were held between October 1990 and March 1991. Workshops for the two Ma'ili classrooms were combined.

The format of these parent workshops were informational, interactive, or a combination of both. Informational workshops used a lecture and discussion format. The interactive workshops involved a parent-child language stimulation activity. The combined workshops included both informational and interactive formats. The importance of a strong language base and language building techniques were first discussed and demonstrated. Then parents were given the opportunity to practice these techniques with their child. Six informational, one interactive and nine combined workshops were presented. During the first year, the initial workshops, held between December 1989 and February 1990, were primarily informational. The later workshops were either interactive or combined.

The following topics were presented:

1. Components of the Project
2. The importance of hearing for language acquisition
3. The effects of ear infections

4. The relationship between hygiene and otitis media
5. The importance of vocabulary and listening skills in language development
6. The use of Standard English
7. Techniques that parents could use at home to improve their child's language skills

The workshops from February through April 1990 emphasized topics five through seven above. Parents and children were involved in art, cooking or reading activities. A description of each workshop can be found in the Parent Workshop Log (Attachment G). In the second year of this project, increased emphasis was placed on parent-child language stimulation activities. The first two workshops were informational. Thereafter, all workshops were combined workshops, and again emphasized topics five through seven above.

All workshops were coordinated with site managers and classroom teachers. Dates, topics of discussion and the types of activity were determined in project staff meetings with managers, teachers and aides.

Parents were informed of upcoming workshops through flyers designed by project staff. These flyers were distributed by classroom teachers. Teachers and project staff also personally reminded parents of upcoming workshops.

A summary of family participation in the workshops is presented in Table 2. A total of 73 families attended the 16 workshops in 1989–90. The overall family participation was 73%. The Ma'ili (2) classroom had 100% of its families participating. For the 1990–91 school year, a total of 79 families attended the workshops. The overall family participation was 83%; for both classes at Ma'ili, 100% of the families participated.

Parent Newsletter

Issues of the "Keiki Kommunicator," a two-page newsletter, were distributed to the parents in the experimental group. The newsletters provided a way to keep parents informed about project activities, share information about children's speech, vocabulary and language development, and involve parents in activities to develop their child's vocabulary and language skills. It was also an opportunity to reach parents who did not attend workshops, and to reinforce topics presented at the workshops for those parents who did attend.

During the first year of the project, only one issue of the newsletter was printed and distributed. During the second year of the project, six newsletters were distributed. The newsletters, which coincided with the workshop topics, were released just prior to each workshop. The six issues of the newsletter included one issue introducing the project, the project staff, and project services. Another issue included information about ear infections, their causes and prevention, and how common ear infections are among children. Two issues were devoted to vocabulary development, and included information on the importance of

vocabulary as a building block for academic success, the importance of the home experience, vocabulary building techniques for parents to use, and ideas on what parents can do to help develop their child's vocabulary. The final two issues were on speech and language development, and included information on normative expectations of how preschoolers should be using language, elements of good preschool language, why parents are important in their child's language development, and ideas on how parents can help develop their child's language skills. Each newsletter also included a parent-child interactive activity which promoted vocabulary and language development. Copies of these newsletters are included as Attachment H.

Classroom Ambient Noise Reduction and Periodic Ambient Noise Measurements

Classroom Ambient Noise Reduction: During the summer of 1989, the Hearing Project contracted with an acoustical engineering firm experienced with work in schools, to conduct an acoustical study of each of the eight classrooms located on O'ahu. Based on these findings and discussions with each of the preschool site managers, the acoustical engineer recommended measures that would be necessary to improve the acoustical environment in the five experimental classrooms. The remaining three classrooms on O'ahu and two on the neighbor islands became the comparison group, with no modifications made to these classrooms.

Though the acoustic engineer recommended modifications in four of the five experimental classrooms, noise abatement work was completed in only one. Several factors, including internal administrative delays, and refusal of the Hawai'i State Department of Education to permit installation of air conditioners proved to be barriers to making the recommended improvements. The remainder of this section describes the findings and recommendations made by the acoustic engineer, and the actions taken by the Project to reduce ambient noise levels in the experimental classrooms.

In classrooms, it has been generally accepted that ambient noise levels due to air conditioning or ventilation systems should not exceed NC 35; in Ulupono A, under the normal setting with both the air conditioner and exhaust fans on, the NC rating was 53.

At Ulupono (the experimental classroom that was subsequently dropped from the study), the main acoustical problem with the two classrooms was the high level of noise generated by the ceiling plenum exhaust fans. In Ulupono A, which was recommended for acoustical treatment, the typical ambient noise level with both the air conditioning and exhaust fans on was 55 dBA, with a corresponding noise criterion (NC) rating of 53. With the air conditioning on and the exhaust fans off, the noise level dropped to 45 dBA (NC 41); with both the air conditioning and the exhaust fans off, the noise level dropped to 35

dBA (NC 28). The reverberation time (RT60), or the time required for a sound to decay by 60 dB after the source of sound has ceased, was 0.4 seconds at 500 Hz, and was within the generally accepted criteria (RT60 at 500 Hz should not exceed 0.5 seconds). However, the ambient noise levels from the ventilation system was far higher than desirable.

To reduce ambient noise to acceptable levels, the acoustic engineer recommended that the exhaust fans and the air conditioning supply ducts be acoustically treated. To prepare specifications for noise control measures, mechanical drawings showing details of the air conditioning system were required by the KS/BE Physical Plant.

In January 1990, a mechanical engineering firm was contracted to prepare plans and specifications for replacing the exhaust fans at Ulupono. Based upon these plans, a request for bids to do the work at Ulupono was issued by the Kamehameha Schools' purchasing office in March 1990. No responses to the bid requests were received. Most contractors were too busy to work on what was considered a "small" job. A second request for bids was issued. One contractor did respond. This sole contractor's bid exceeded the total amount budgeted for ambient noise reduction in all five classrooms. Thus it was not possible to complete the noise abatement work before the start of the Fall 1990 school year. No further effort was made to contract for this task, and no work was done in the Ulupono A classroom.

At Ma'ili, the main acoustical problem associated with the four classrooms was occasional noise from the adjacent medical center parking lot. Also, the ventilation fans, which were installed so that the jalousie windows and roll-up doors could be closed at times of noticeable noise intrusion, were themselves too noisy to be used. The acoustical engineer recommended classrooms 1 and 2 be selected for acoustical treatment. The ambient noise level measurement in Ma'ili (1) was approximately 40 dBA (NC 32) with the exhaust fan off and the jalousie windows open. With the exhaust fan on, the ambient noise level rose to 59 dBA (NC 58). With the exhaust fan off, the typical ambient noise level (NC 32) and the reverberation time, (0.4 seconds at 500 Hz) were within the generally accepted criteria. With the exhaust fan on, the ambient noise level was far higher than desirable.

The acoustic engineer recommended that the existing exhaust fans be replaced with silenced units. The mechanical engineering firm contracted to do the work at Ulupono also drew up plans for the two Ma'ili classrooms. These plans went far beyond noise abatement (including structural modifications) and would have required construction so expensive and time consuming that they were beyond the parameters of the Project. Rather than replacing the exhaust fans, the KS/BE Physical Plant replaced the single-speed fan switches with variable-speed switches. Sound level measurements taken after the switches were replaced indicated 4 to 6 dBA decrease in noise level. Since the Project was by this time nearing completion, no further work was done in the two Ma'ili classrooms.

At Kahuku, the main acoustical problem was noise from nearby construction activities and occasional helicopter flights to and from a nearby hospital. At the time the measurements were taken, however, construction work had ended for the day. The ambient noise level inside the classroom was approximately 37 dBA (NC 32), with the windows open. The measurement was in compliance with the generally accepted criteria. However, the reverberation time measurement, with the classroom unoccupied, was 0.7 seconds at 500 Hz, marginally higher than desirable. The Kahuku Preschool is located on the grounds of Kahuku Hospital. While the preschool program is operated by the Kamehameha Schools, the physical location of the classroom belongs to the Hospital. Therefore, prior to doing the noise abatement work, it was necessary to discuss the modifications planned with the Hospital's administrator and obtain his approval. It was recommended that wall-mounted air conditioners be installed so that the windows could be kept closed, providing some relief from the construction noise. In addition, the installation of an acoustical tile ceiling below the existing ceiling was also recommended to reduce reverberation time.

Although the installation of air conditioning was recommended, the acoustic engineer also advised that many types of wall-mounted air conditioning units generate far higher noise levels than are desirable for a classroom environment. With the help of the acoustic engineer, conventional wall-mounted and split-type air conditioners were assessed. The split-type air conditioners, with the compressor/condenser located outdoors, proved to be significantly quieter than the conventional wall-mounted units. Based on the engineer's report, and noise level measurements of a unit in operation, a split-type air conditioner was purchased. The air conditioner was installed in June 1990.

The acoustic ceiling panels were purchased using Hearing Grant funds and installed by KS/BE Physical Plant carpenters. Arrangements were made to install the ceiling during the one week spring break so that class time would not be disrupted. The work was completed in March 1990. The ceiling panels were not installed according to the method recommended by the consulting engineers. Rather than using the standard exposed "T" bar suspension system or an adhesive, the ceiling panels were simply nailed to the existing gypsum board ceiling. In his follow-up report, the acoustic engineer noted that the ceiling tiles were warped or falling off in some places.

The follow-up reverberation time measurements showed a significant improvement. The RT60 at 500 Hz was 0.3 seconds, reducing the reverberation time by about one-half. (see Figure 4) The ambient noise level measures were consistent with the measures taken in Summer 1989. No further work was done at Kahuku.

The remaining two experimental classrooms, Nanakuli and Nanaikapono, are located in Hawai'i State Department of Education (DOE) schools.

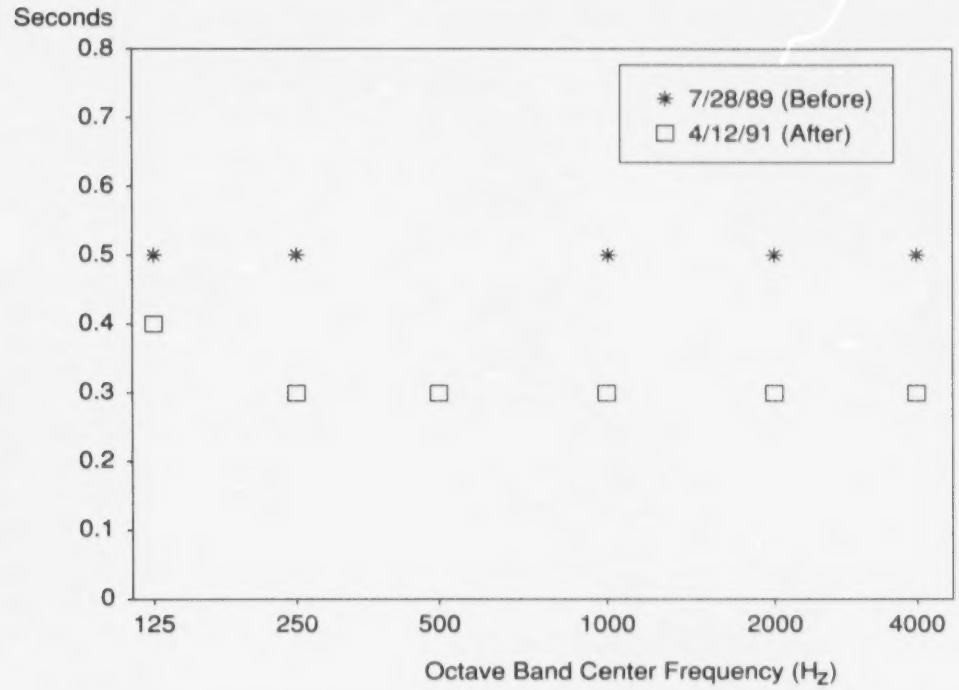


Figure 4. Reverberation Time Measurements Before and After Ceiling Treatments — Kahuku

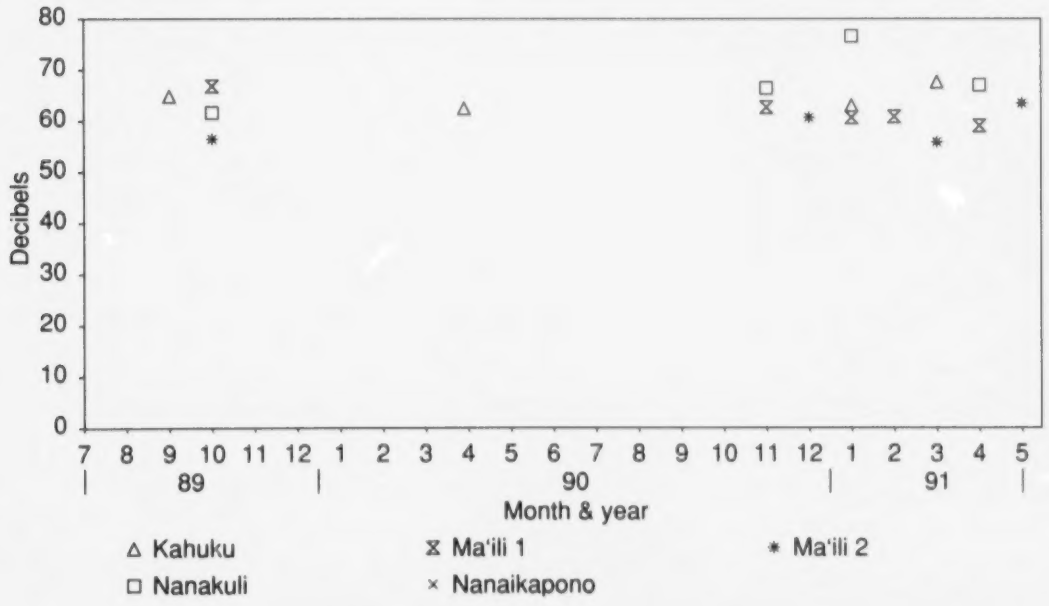


Figure 5. Noise Level Measurements: Large Group; Windows/Doors Open; Amplification On; Fan Off

The ambient noise measurements in the Nanakuli classroom were generally acceptable, at 37 dBA (NC 32), with the jalousies open and the school grounds largely unoccupied. The report indicated that there was some noise from the movement of students along the exterior corridors, and the exterior sounds were readily transmitted into the classroom through the jalousies along the two exterior walls. The reverberation time, measured at 0.5 seconds at 500 Hz, was within the generally accepted criteria. The site manager advised that she would like to have a wall-mounted air conditioning unit installed in the classroom. While no modifications were recommended for this classroom, the engineer noted that the installation of an air conditioning unit would be advantageous in terms of reducing exterior noise intrusion from corridor movements, as it would allow the jalousies to remain closed. The Department of Education would not permit air conditioning to be installed. (See Attachment I)

At the time the noise level measurements were taken at Nanaikapono, the classroom was undergoing reconstruction. The engineers were unable to perform any meaningful interior noise measurements, but did record exterior noise measurements near the classroom wall most affected by traffic noise. The L10 noise level, or the level exceeded for 10% of the time and a common measure of the more intrusive components of traffic noise, was measured at 63 dBA. The engineers estimated an interior L10 noise level due to the road traffic at 50 to 55 dBA, which is significantly higher than the desirable ambient noise level of 45 dBA or less, and higher than the Hawai'i State Department of Health's 50 dBA upper limit inside school classrooms. The installation of air conditioners was recommended. This would allow the jalousies and sliding glass doors to remain closed, minimizing intrusive noise from road traffic. The installation of carpeting over most or all of the floor space was recommended to assist in controlling both reverberant noise and footfall noise. Alternatively, 30% of the wall area could be treated with special sound absorbing panels.

A second visit to assess noise levels in the classroom was made after the construction work had been completed. The L10 measure taken inside the classroom with the sliding doors and jalousies open, was recorded at 59 dBA; with the jalousies and sliding doors closed, read 49 dBA.

The data from the second visit confirmed that to reduce interior noise levels, it was necessary to keep the jalousies and sliding doors closed. This could be accomplished only if the classroom was air conditioned or force ventilated and ceiling mounted fans installed. If neither of these approaches were acceptable, the engineer suggested building an eight foot high sound barrier wall at the edge near the sliding glass doors. This would provide a 5 to 7 dBA reduction in traffic noise.

Prior to making these improvements, the Hearing Project sought permission from the DOE to proceed with the work. The process was extremely lengthy (5 months), caused by

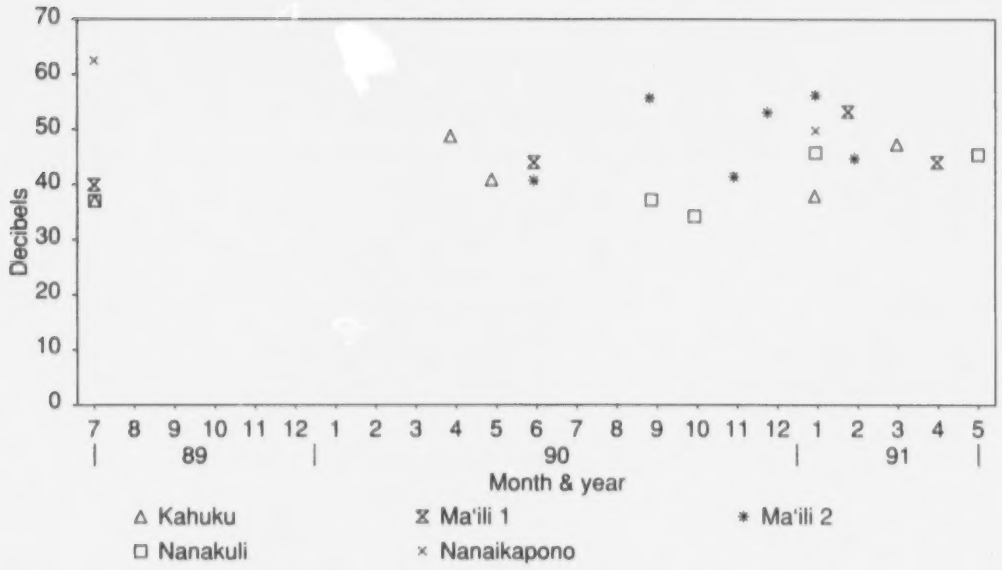


Figure 6. Ambient Noise Level Measurements: Room Unoccupied; Windows/Doors Open; Fan Off

both KS/BE and DOE administration delays. The proposed noise abatement work, i.e., the installation of air conditioners at Nanakuli and air conditioners and carpeting at Nanaikapono, was discussed among KS/BE administrators with DOE administrators from the state, district and school levels. After several months, the project was informed that our request to install air conditioning was denied because a letter from the Assistant Superintendent stated, "The Department's policy is that all school buildings must comply with the DOE's Educational Specifications and Standards for Facilities. Since the standard does not allow for air-conditioning of classrooms, this is to advise you that the request must be denied." (Attachment I).

The possibility of building the sound barrier was rejected by the DOE because of classroom security problems associated with building such a high wall. At Nanaikapono, carpeting was installed over a portion of the floor space. No further noise reduction work was done in the classroom.

Periodic Ambient Noise Measurements: In addition to the initial sound level measurements taken by the acoustic engineer, the Hearing Project's audiologist took sound level readings in each of the five experimental classrooms. The measurements were taken throughout the school year. A Quest Electronics Model 155 sound level meter set to the A scale slow response mode was used to measure ambinent noise levels. The measurements were taken in the large group instruction area in the classroom. The two measurement conditions were an unoccupied classroom and an occupied classroom during large group instructional time with the teacher's voice amplified. Measurements in the

unoccupied classroom were usually taken 30 minutes before the children were allowed to enter the classroom. The measurements were taken in the normal operational setting; that is, air conditioned rooms had their doors and windows closed; in rooms without air conditioning, the windows and/or doors were open.

The levels reported were an estimate of the average level of sound in the room. The audiologist measured the sound level over a period of five to ten minutes and selected the most consistent level. Very high and very low levels were disregarded. Overall, the ambient noise levels in each classroom were very consistent, varying no more than 10 dB over the two year period of the project. These readings are displayed in Figures 5 and 6.

The consistency of the ambient noise measures were also seen in the Kahuku classroom, where the acoustic ceiling panels were installed. Although there was no significant change in sound level measurements, there was a significant improvement in the reverberation time measurement (Figure 4). Comments from the teacher and aide, as well as observations by the Project staff noted an improvement in the acoustic quality of the classroom. The teacher's voice was audible from a distance of 15 to 20 feet; footfall noises were less noticeable; and the room seemed much quieter even when the children were in their play centers.

The proposed component "reduction of ambient noise", was possible to implement in only one of the five experimental classrooms.

Classroom Amplification

To ensure maximum benefit from instructional time, free-field amplification was installed in the five experimental classrooms. At the time the equipment was purchased, the Audio Enhancement System Omni–2001 was the only commercial system being produced. The system included the following:

1 M–72L transmitter
1 MR–72 receiver-amplifier SC 2001
1 NBC 9–2 charger
1 microphone, M4010 (omni-directional) or M4012 (unidirectional)
1 NC9–110 rechargeable battery
1 SC2002 add-on speaker set (two speakers)
1 P–1 belt-clip carrying pouch
1 CB–48 attenuating cord
1 1/4" adapter standard jack

Initial installation and training to use the system was provided by an Audio Enhancement Company representative. The audiologist assisted the representative in

installing the systems in the experimental classrooms and was provided with hands-on experience on simple maintenance and troubleshooting procedures, operation of the system, speaker placement, etc. The Audio Enhancement representative also conducted an in-service training workshop for the teachers, aides, and Project staff.

Before installing the equipment in each room, the main instructional area was determined. The amplifier and add-on speakers were then placed at the back and to the sides of this instructional area. This arrangement provided amplified sound from all directions. Wherever possible the equipment was placed at children's ear level, out of the way of traffic. Many of the classrooms were divided by shelves so cords to the speakers could not be run along the classroom wall. In these classrooms the cords were either taped to the floor or covered with cord covers that were in turn taped to the floor. The audiologist installed the amplifier and speakers at the beginning of the school year and at least once more time during the school year after the carpets were shampooed or the floors polished.

After the equipment was installed a sound level reading was taken and the amplifier volume adjusted to produce a voice level that was 10 dB above the ambient noise level in the classroom. In general, the volume control was adjusted to provide an approximate gain of 10 dB. The teachers and aides were also instructed to readjust the volume level if necessary. While a listener stood in the center of the instructional area, a third party adjusted the volume control knob until the speaker's voice was at a comfortable, audible level. The audiologist took periodic sound level readings in each classroom and made adjustments as well.

Teachers, aides and children used the amplification equipment daily, mostly during large group instruction. The wireless microphone allowed them freedom to move around the room as they talked. Their voices could be heard clearly wherever they were in the room. The children also used the amplification equipment while participating in morning circle activities, sharing information, or leading their class in prayer before snack or lunch. Amplification was also used to increase the sound from the record player or the television. The amplifier could be converted into a portable unit with two six-volt batteries. Several teachers used the amplifier for outdoor activities.

CHAPTER III
Findings

Since the first year of the project was used to pilot-test the interventions, train the project staff, participating teachers and aides, and attempt to make acoustic changes in the experimental classrooms, the presentation of findings will be based on the second year (1990–91) of the project. Summaries of data from the first year are provided in Attachment J. In a few instances, such as comparison of test results from year to year, 1989–90 school year data will be included here.

What was the incidence of hearing, middle-ear disorder, and speech problems?

In the Fall (entry) screening, 36% of the preschoolers failed the audiometric screening, 26% failed tympanometry, and 36% failed the otoscopic examination (see Figure 7). When combined, these produced a 60% failure rate (Figure 8). The results of the acoustic reflectometry screenings are shown in Figure 1.

As shown in Figure 8, the periodic screening (audiometry and tympanometry every three weeks) approximately 30% of the children failed at each of the six periodic (or seven including the fall screening). By the end of the school year, more than 70% of the children had failed at one or more of the testing intervals (Figure 9).

Detailed results of the hearing loss and middle-ear disorder screening are given in Attachment K.

Nearly a third (32%) of the preschoolers in the experimental group were found to need individual speech-language therapy. The severity of these problems ranged from mild to severe. However only three of these 29 cases were rated as severe. Communication, language, and articulation problems were much more common than fluency problems (see Table 3).

Were the project and comparison groups sufficiently comparable?

Since the hypothesis of this project was "that Kamehameha Schools could achieve a demonstrable improvement in the language competence of Hawaiian children by introducing an integrated six-component communication program into preschool classrooms." the initial comparability of the two groups is an important design question. The two groups of classrooms were tested for significance of difference on several types of variables; demographic, health history, hearing loss and middle-ear disorder screening, speech, and achievement test scores.

The results of comparing the groups on six key demographic variables are shown in Table 4. A significant difference was found on two of these variables: number of persons in

the household, and median household income. The "Possible Problem" group has a larger mean "Number in Household" in the comparison group. However, since the group means for the "Pass" and "Fail" groups are not significantly different, and since the N is very small (five) in the comparison group/"Possible Problem" group, this finding is considered to be of no consequence. The median household income for the comparison group is higher than the median income for the experimental group.

Health history variables in experimental and comparison classrooms are compared in Table 5. A significant difference was found on four (birthweight, asthma, history of prior hospitalization, and prior hearing or speech evaluation) of the 18 variables. Two of these differences favored the experimental group and two favored the comparison group.

Hearing loss and middle ear disorder screening comparisons are shown in Table 6. No significant differences between groups were found in the results of the 1989–90 hearing screening. The 1990–91 results indicate significant differences between groups on audiometry and consequently in the summary status.

Speech screening results are given in Table 3. In both Fall 1989 and Fall 1990, no significant differences were found between the experimental and comparison groups.

Table 7 and Figure 10 show the mean test scores for the two groups. Though the comparison group had higher Fall (pretest) scores than the experimental groups on all tests, these differences were not statistically significant. Since the project attempts to improve the *growth* (post minus pre) in achievement test scores, these differences are not considered critical. Growth in test scores generally showed little relationship to demographic and health history variables. (see Tables 8 and 9)

These analyses indicate that, with isolated or nonsignificant exceptions, the two groups are, in fact, sufficiently comparable to test the central hypothesis of the project.

Are screening results related to performance levels on achievement tests?

The groups of children who passed and failed the hearing loss /middle-ear disorder screening and those who passed and failed the speech screening were tested for significance of difference on average score on the achievement tests given at entry to preschool. The results of these analyses for hearing loss/middle-ear disorder screening are given in Table 10 and Figure 11. There are significant differences between the pass and fail groups on several of the verbal tests. No significant differences were found on the test of quantitative concepts.

The results of the tests for significant achievement test score differences between "Acceptable" and "Not Acceptable" groups on the speech screening variables are given in Table 11 and Figure 12. Significant differences were found on the Language and

Communication components of the speech screening but not on the Articulation and Fluency components. It should be noted that only 7 of the 173 preschoolers screened for fluency failed.

In general, preschoolers who fail components of the speech or the hearing loss/middle-ear disorder screening score significantly lower on achievement tests, especially on tests of language performance. These findings are consistent with data accumulated in each of the five previous years.

How do children who pass the screening differ from those who fail?

Pass and fail groups on the screening were compared on demographic (Table 4 and Table 12) and health-history variables (Table 13) . Also, the relationship between speech screening and hearing loss/middle-ear disorder screening results was tested for significance (Table 14).

Fewer entering preschoolers who failed the hearing loss/middle-ear disorder screening had been breastfed and those who were, were breastfed for a shorter length of time. Children classified as "Possible Problem" were slightly older than those in either the "Pass" or "Fail" categories.

There were no significant differences in demographic or health-history variables between those children who failed the speech screening and those who passed.

Table 14 shows no relationship between performance on the speech screening tests and the results of hearing loss/middle-ear disorder screening. The "Voice"/Acoustic Reflectometry table entry is irrelevant for our purposes since acoustic reflectometry was not a part of our screening battery.

Do Hawaiian children differ from non-Hawaiians on the screening, demographic, and health history variables?

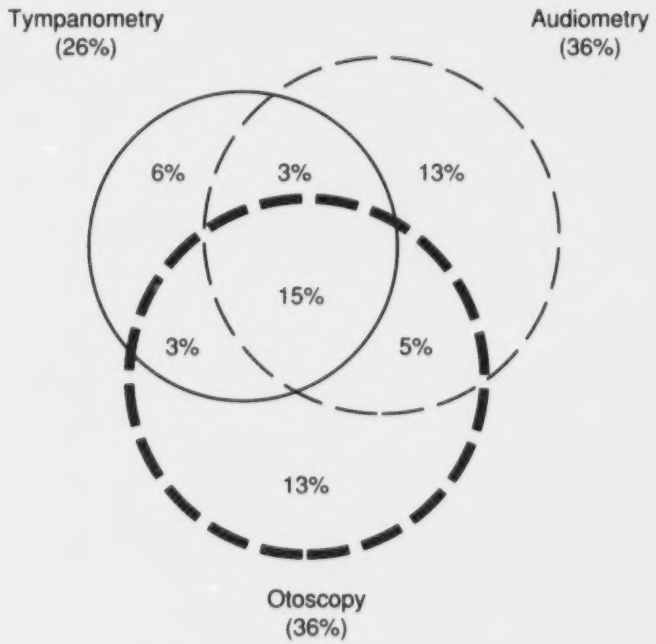
The results of testing for significant differences between Hawaiian and non-Hawaiian preschoolers on screening variables and achievement test performance are shown in Table 15. The data show significant differences on test scores but not on screening variables. However it should be noted that Kamehameha preschools include only about 15% non Hawaiians. Recent data from the Hawai'i State Department of Health show that, in their much larger screening population, 22% of the children screened are Hawaiian while 32% of those who fail the screening are Hawaiian. (Stewart, Anae and Gipe, 1989, p. 78, Table 2)

Significant differences between Hawaiian and non-Hawaiian children were found on several demographic and health history variables. These are reported in Table 16.

Hawaiian children are more likely to come from single-parent families, families who receive public aid, are more likely to have had previous ear infections and head injuries. They have lower family incomes and lower test scores than their non-Hawaiian classmates.

Did the children in the experimental classes show more growth in achievement than children in the comparison group classes?

Children in the experimental group showed nearly 25% more growth on verbal and quantitative tests than those in the comparison group (see Figure 13 and Figure 14). This difference is both statistically and educationally significant. The central hypothesis of the study was confirmed.



Note: Does not sum to 100% due to rounding.

Figure 7. Percent "Fail" by Screening Method, Fall 1990: Experimental and Comparison Groups Combined (N=171)

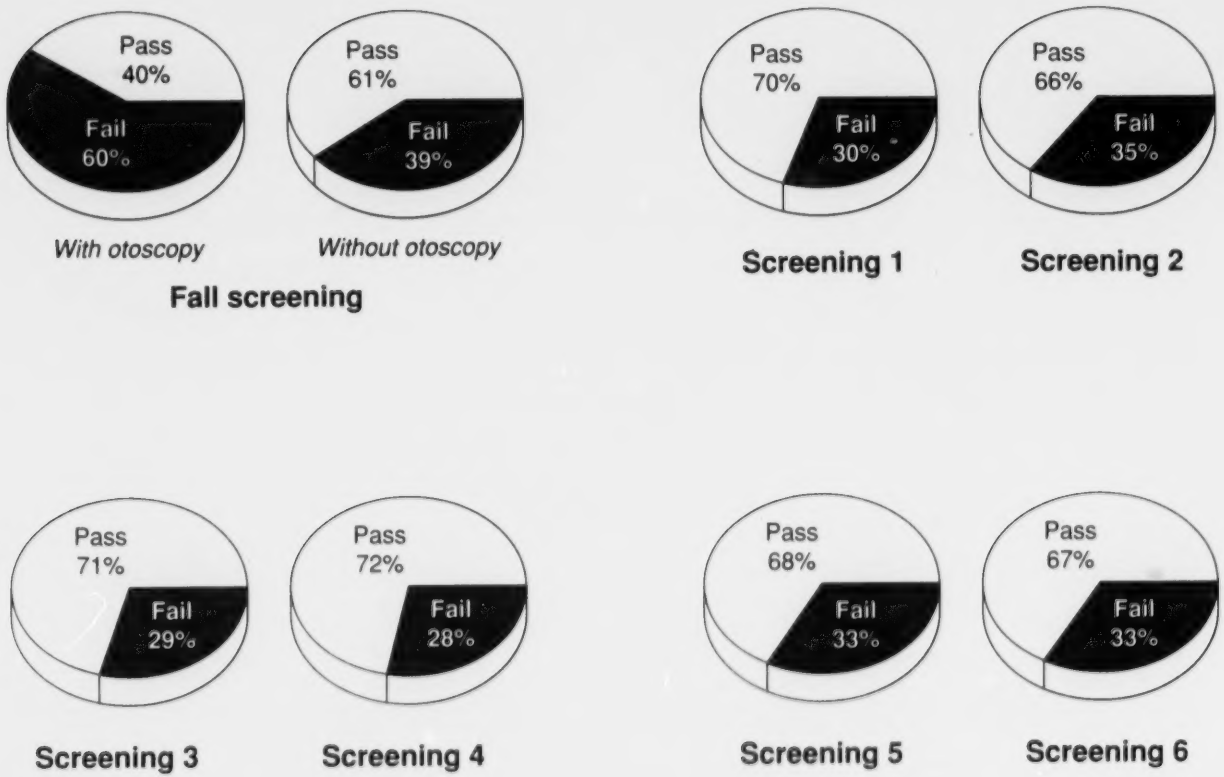


Figure 8. Periodic Hearing Loss and Middle-Ear Disorder Screening Results, 1990–91

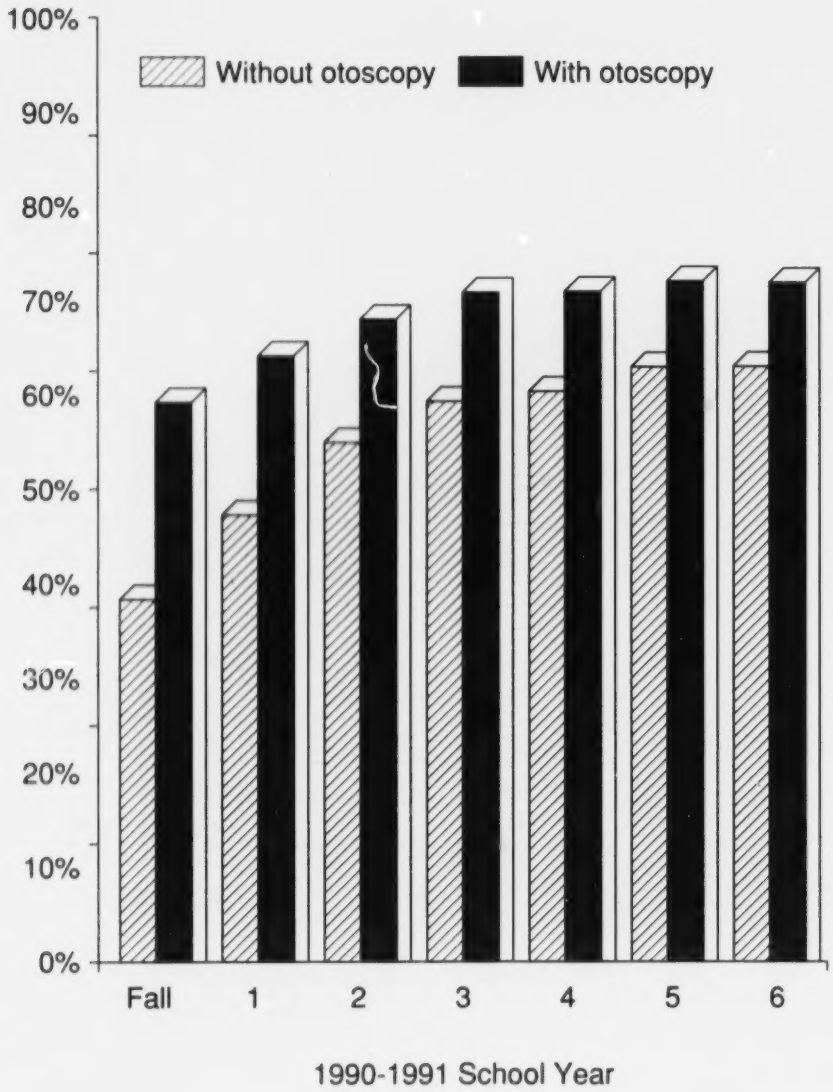


Figure 9. Cumulative Fail Rate on Hearing Screen Pass/Fail, with and without Otoscopic Findings, 1990–91 School Year

Table 3. Speech/Language Screening Results: Fall 1989 and Fall 1990

Test	Experimental 1989 (N=95) %	Experimental 1990 (N=90) %	Comparison 1989 (N=83) %	Comparison 1990 (N=88) %	Significantly Different[2] 1989	Significantly Different[2] 1990
Articulation						
Acceptable	83.8	79.6	81.9	79.8		
Retest	10.1	2.3	8.5	9.5		
Refer	6.7	18.2	9.6	10.8	No	No
Language						
Acceptable	34.8	67.1	50.6	67.9		
Retest	56.2	12.5	42.2	20.2		
Refer	9.0	20.5	7.2	11.9	No	No
Fluency						
Acceptable	96.7	93.2	96.2	98.8		
Retest	2.2	3.4	2.5	–		
Refer	1.1	3.4	1.3	1.2	No	No
Communication[1]						
Acceptable	11.0	63.6	19.2	58.3		
Retest	68.1	11.4	70.5	25.0		
Refer	20.9	25.0	10.3	16.7	No	No

[1]Communication rating is based on teacher's rating of students.

[2]For analysis purposes, the Retest–8 months and Retest–4 months were collapsed into "Retest"; the diagnostic evaluation and medical referral categories were combined into a "Refer" category.

Significance of differences between Experimental/Comparison groups were tested using Chi-Square at the .05 level.

Table 4. Comparison of Hearing Loss and Middle-Ear Disorder Screening Findings by Demographic Variables and Group, Fall 1990

Demographic variable	Audiometry		Tympanometry		Acoustic Reflectometry		Otoscopy		Summary Status						Significantly Different?	
	Pass		Pass		Pass		Pass		Pass		Possible Problem		Fail		Pass/ Fail	Exp./ Comp.
	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)		
Sex (female)																
Experimental	78.0	32	63.0	26	90.0	37	63.0	26	42.0	17	32.0	13	27.0	11		
Comparison	58.0	25	79.0	34	88.0	38	72.0	31	49.0	21	7.0	3	44.0	19		
Total	68.0	57	71.0	60	89.0	75	68.0	57	45.0	38	19.0	16	36.0	30	No	No
Aid recipient (yes)																
Experimental	68.0	25	65.0	24	92.0	34	68.0	25	41.0	15	24.0	9	35.0	13		
Comparison	28.0	5	67.0	12	83.0	15	61.0	11	22.0	4	-	-	78.0	14		
Total	55.0	30	65.0	36	89.0	49	65.0	36	35.0	19	16.0	9	49.0	27	No	No
Both parents in household (yes)																
Experimental	79.0	41	67.0	34	96.0	50	60.0	31	39.0	20	33.0	17	27.0	14		
Comparison	60.0	38	78.0	49	90.0	57	68.0	43	51.0	32	6.0	4	43.0	27		
Total	69.0	79	73.0	83	93.0	107	64.0	74	46.0	52	18.0	21	36.0	41	No	No
	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)	Mean	(N)		
Age in months																
Experimental	49.5	31	50.5	61	50.5	6	51.2	52	50.0	35	51.4	28	48.6	24		
Comparison	48.6	19	48.4	66	48.4	8	49.3	37	48.8	38	51.4	5	49.6	42		
Total	49.1	50	49.9	127	49.6	89	49.6	89	49.4	73	51.4	33	48.9	66	Yes*	No
Number in household																
Experimental	6.2	31	5.8	58	5.3	6	6.1	52	5.8	35	5.7	24	6.7	24		
Comparison	4.8	19	5.0	65	4.1	8	5.0	37	4.8	38	7.0	5	5.5	40		
Total	5.7	50	5.4	123	4.6	14	5.7	89	5.3	73	5.9	29	5.9	64	No	Yes*
Median household income																
Experimental	16,500		19,000		16,071		15,625		20,500		14,000		11,667			
Comparison	24,062		22,500		21,750		22,188		22,188		25,000		16,000			
Total	21,667		21,094		19,474		19,999		19,999		17,500		14,643		No	Yes*

Note: The significance test used for the variables sex, aid recipient, both parents in household and household income was chi-square.
The significance test used for the variables age in months and number in household was ANOVA.
*Significant at .05 level.

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Table 5. Comparison of Experimental and Comparison Groups on Health History Variables, Fall 1990

Health Variable	Experimental %		Comparison %		Significantly Different?*
Birthweight					Yes*
32-112 oz.	34.9		38.1		
113-128 oz.	26.7		40.5		
129+ oz.	38.4		21.4		
	Yes %	No %	Yes %	No %	
Problems or complications during pregnancy or delivery					
pregnancy	11.4	88.6	8.2	91.8	No
delivery	10.2	89.8	4.7	95.3	No
Child breastfed	71.3	28.7	70.6	29.4	No
Use of bottle or pacifier when putting child to bed	19.3	80.7	18.8	81.2	No
Child have breathing problems	6.8	93.2	8.2	91.8	No
Child have problems talking	3.5	96.5	4.7	95.3	No
History of illness, ear infection and injury					
high fever (103+)	39.1	60.9	48.2	31.8	No
ear infection	72.7	27.3	60.0	40.0	No
head injury	11.5	88.5	5.9	94.1	No
allergy	8.1	91.1	15.	84.7	No
asthma	13.8	86.2	27.1	72.9	Yes*
History of hospitalization or surgery	30.7	69.3	17.9	82.1	Yes*
Prior speech or hearing evaluation	52.9	47.1	35.3	64.7	Yes*
Any concerns about child's speech or hearing	-	84.1	-	85.7	
hearing only	3.4	-	6.0	-	
speech only	9.1	-	6.0	-	
both speech and hearing	3.4	-	2.4	-	No
	Mean		Mean		
Number of months child breastfed	5.2		5.1		No
Episodes of ear infection	4.5		3.6		No
Number of smokers in house	1.0		0.9		No

Note: Significance of difference between groups test used for mean number of months breastfed, mean episodes of ear infection and number of smokers in the house was ANOVA; chi square was used to test the significance of differences between groups for other health variables

* Significant at the .05 level

Table 6. Hearing Loss and Middle-Ear Disorder Screening Results by Group: Fall 1989 and Fall 1990

	Experimental		Comparison		Significantly Different	
	1989 (N=95)	1990 (N=90)	1989 (N=83)	1990 (N=88)	1989	1990
Test	%	%	%	%		
Audiometry						
Pass	67.4	76.1	77.1	52.9		
Fail	32.6	23.9	22.9	47.1	No	Yes*
Tympanometry						
Pass	83.2	70.1	85.5	77.7		
Fail	16.8	29.9	14.5	22.3	No	No
Otoscopy						
Pass	42.2	61.4	54.9	67.1		
Fail	57.5	38.6	45.1	32.9	No	No
Acoustic Reflectometry						
Pass	91.6	94.3	90.4	89.4		
Fail	8.4	5.7	9.6	10.6	No	No
Summary Status						
Pass	28.7	40.2	45.1	44.7		
Possible Problem	39.4	32.2	24.4	5.9		
Fail	31.9	27.6	30.5	49.4	No	Yes*

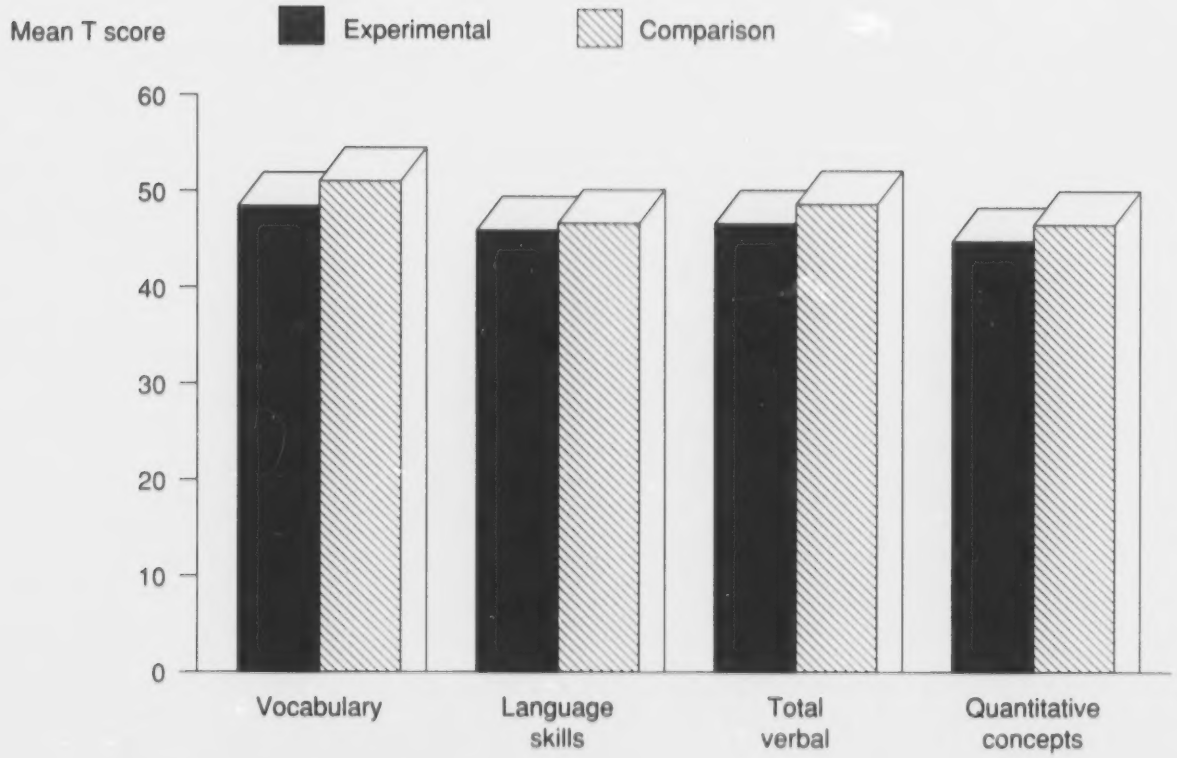
Notes: Fall results include only those cases with fall hearing loss and middle-ear disorder screening and pre and post-achievement test data. Significance of difference between Experimental/Comparison groups was tested by Chi-Square. ASHA Guidelines changed between the 1989 and 1990 screening.
* Significantly different at the .05 level.

Table 7. Mean Test Scores by Experimental and Comparison Groups, 1989–90 and 1990–91 School Years

See Table 7 errata page 80.

	Fall		Sig.	Spring		Change		Sig.
Test	Exp.	Com.	Diff.	Exp.	Com.	Exp.	Com.	Diff.
				1989–90 School Year				
Vocabulary	48.9	50.6	No	56.4	55.3	7.4	4.7	Yes*
Language Skills	46.7	46.4	No	58.4	58.1	11.7	11.8	No
Total Verbal	47.7	48.5	No	57.3	56.7	9.6	8.2	No
Quant. Concepts	46.1	46.9	No	61.4	61.3	15.3	14.4	No
				1990–91 School Year				
Vocabulary	48.5	51.2	No	57.5	57.4	9.0	6.3	Yes*
Language Skills	46.3	47.2	No	60.6	60.2	14.4	13.0	Yes
Total Verbal	47.4	49.3	No	59.1	58.8	11.7	9.6	Yes*
Quant. Concepts	45.6	47.5	No	63.5	60.8	17.8	13.4	Yes**

Note: Reported in T score form. ANOVA was used to test for differences between experimental and comparison groups.
* Significant at .05 level.
** Significant at .01 level.



Note: Reported in T score form

Figure 10. Mean Test Scores of Experimental and Comparison Groups, Fall 1990

Table 8. Mean Change in Test Scores by Health History Variables, 1990–91 School Year

Health Variable	Total Verbal Test Score N	Mean change	Sig.	Quantitative Concepts Test Score N	Mean change	Sig.
Birthweight			No			No
32-112 oz.	61	10.7		62	15.7	
113-128 oz.	54	10.7		57	16.2	
129+ oz.	50	10.4		50	15.8	

	Yes N	Yes Mean change	No N	No Mean change	Sig.	Yes N	Yes Mean change	No N	No Mean change	Sig.
Problems or complications during pregnancy or delivery										
pregnancy	15	12.6	153	10.5	No	17	18.0	155	15.7	No
delivery	13	13.9	155	10.4	Yes*	13	18.2	159	15.7	No
Child breastfed	118	10.1	49	11.9	No	121	15.8	50	15.9	No
Use of bottle or pacifier when putting child to bed	32	12.0	136	10.4	No	33	15.2	139	16.1	No
Child have breathing problems	12	13.0	156	10.5	No	13	12.8	159	16.2	No
Child have problems talking	7	11.1	160	10.7	No	7	16.1	164	16.0	No
History of illness, ear infection and injury										
high fever (103+)	72	10.6	95	10.7	No	74	15.7	97	15.9	No
ear infection	112	10.9	56	10.3	No	114	16.6	58	14.7	No
head injury	14	11.8	153	10.6	No	15	17.3	156	15.7	No
allergy	19	10.4	148	10.7	No	20	15.9	151	15.8	No
asthma	33	9.7	134	10.9	No	35	14.8	136	16.1	No
History of hospitalization or surgery	41	11.3	126	10.5	No	42	15.3	129	16.2	No
Prior speech or hearing evaluation	74	10.6	93	10.7	No	75	18.2	96	14.0	Yes**
Any concerns about child's speech or hearing										
hearing only	8	6.3	142	10.7	Yes*	8	8.6	145	16.3	Yes*
speech only	13	11.4	142	10.7	No	13	15.5	145	16.3	No
both speech and hearing	4	15.8	142	10.7	No	5	15.0	145	16.3	No

	Correlation between health variable and total verbal change score	Sig.	Correlation between health variable and quantitative concepts change score	Sig.
Number of months child breastfed	-0.118	No	0.016	No
Episodes of ear infection	0.006	No	0.010	No
Number of smokers in house	0.100	No	-0.040	No

Notes: Reported in T score form. Significance test used was ANOVA for all variables except number of months breastfed, number episodes of ear infection and number of smokers in house. Correlation coefficient was used for these variables.

* Significant at the .05 level ** Significant at the .01 level

Table 9. Mean Change in Test Scores by Demographic Variables, 1990–91 School Year

Demographic Variable	Verbal Test		Quantitative Test	
	Change	Significantly Different?	Change	Significantly Different?
Sex		No		No
Female	11.0		15.5	
Male	10.2		15.6	
Aid Recipient		No		No
Yes	11.1		15.7	
No	10.2		15.5	
Both Parents in House		No		No
Yes	10.3		15.3	
No	11.2		16.2	
	Correlation		Correlation	
Age in Months	.169	No	.150	No
Number in Household	.157	No	.026	No
Household Income	.218	Yes*	.009	No

Notes: Reported in T score form. Significance test use for Sex, Aid Recipient, and Both Parents in House was ANOVA; significance test used for Age in Months, Number in Household, and Household Income was the Correlation Coefficient.
*Significant at .05 level.

Table 10. Mean Test Scores of Pass/Fail Groups by Screening Method and Summary Status, Fall 1990

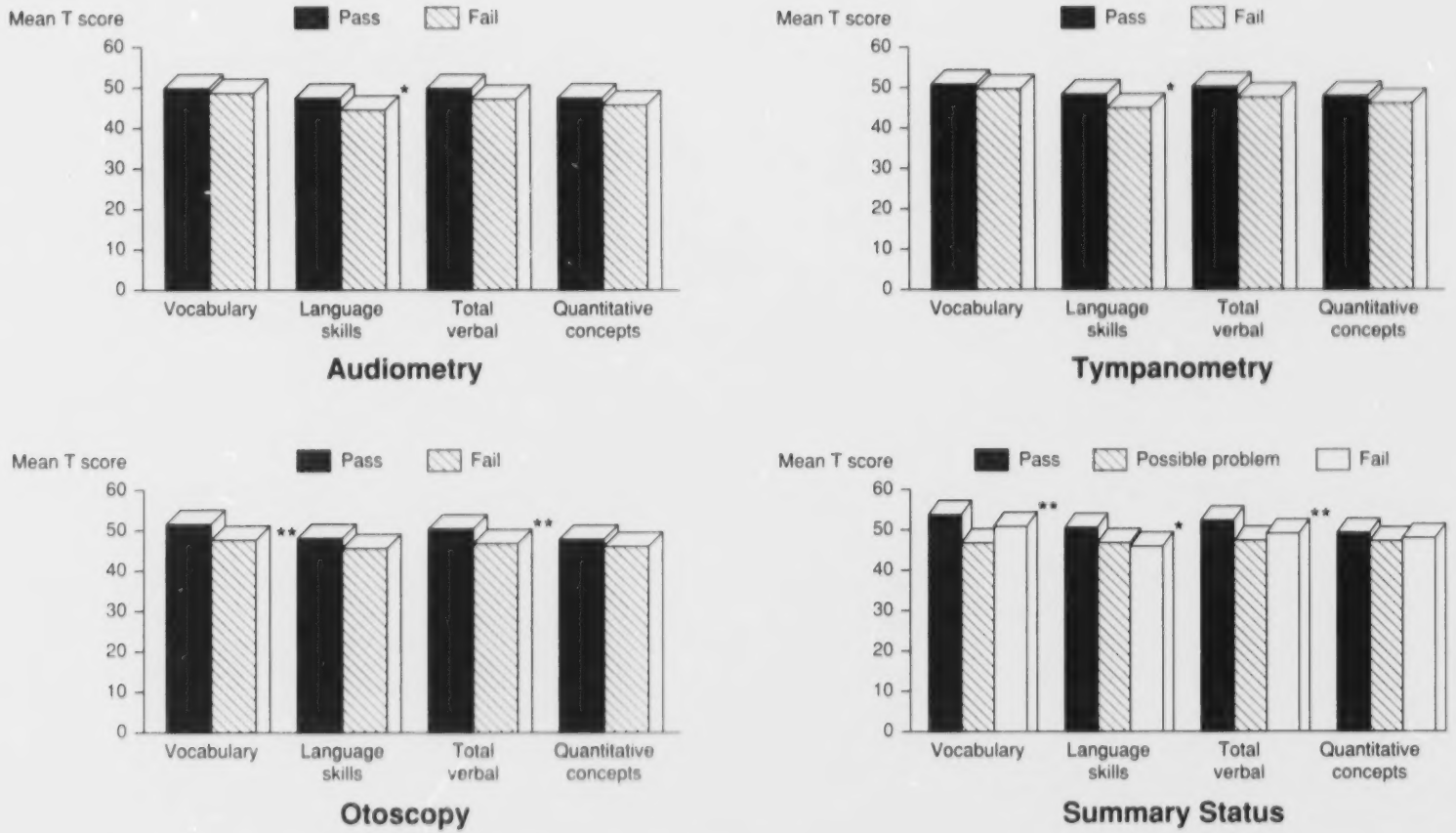
	Audiometry		
	Pass (N=112)	Fail (N=61)	Significantly Different?
Vocabulary	50.1	48.9	No
Language Skills	47.6	44.5	Yes*
Total Verbal	49.0	46.8	No
Quant. Concepts	46.8	45.2	No

	Tympanometry		
	Pass (N=128)	Fail (N=45)	Significantly Different?
Vocabulary	50.0	48.6	No
Language Skills	47.5	44.0	Yes*
Total Verbal	48.8	46.4	No
Quant. Concepts	46.6	45.0	No

	Otoscopy		
	Pass (N=111)	Fail (N=62)	Significantly Different?
Vocabulary	51.3	46.8	Yes**
Language Skills	47.4	44.9	No
Total Verbal	49.5	45.9	Yes**
Quant. Concepts	46.8	45.1	No

	Summary Status			
	Pass (N=73)	Possible Problem (N=34)	Fail (N=66)	Significantly Different?
Vocabulary	52.1	45.2	49.1	Yes**
Language Skills	48.6	45.8	44.6	Yes*
Total Verbal	50.5	45.6	46.9	Yes**
Quant. Concepts	47.2	45.3	45.6	No

Note: Reported in T score form.
* Significant at the .05 level.
** Significant at the .01 level.



Note: Reported in T score form *Significantly different at the .05 level
**Significantly different at the .01 level

Figure 11. Mean Test Scores of Pass/Fail Groups by Screening Method and Summary Status, Fall 1990

Table 11. Mean Test Scores by Speech Screening, Fall 1990

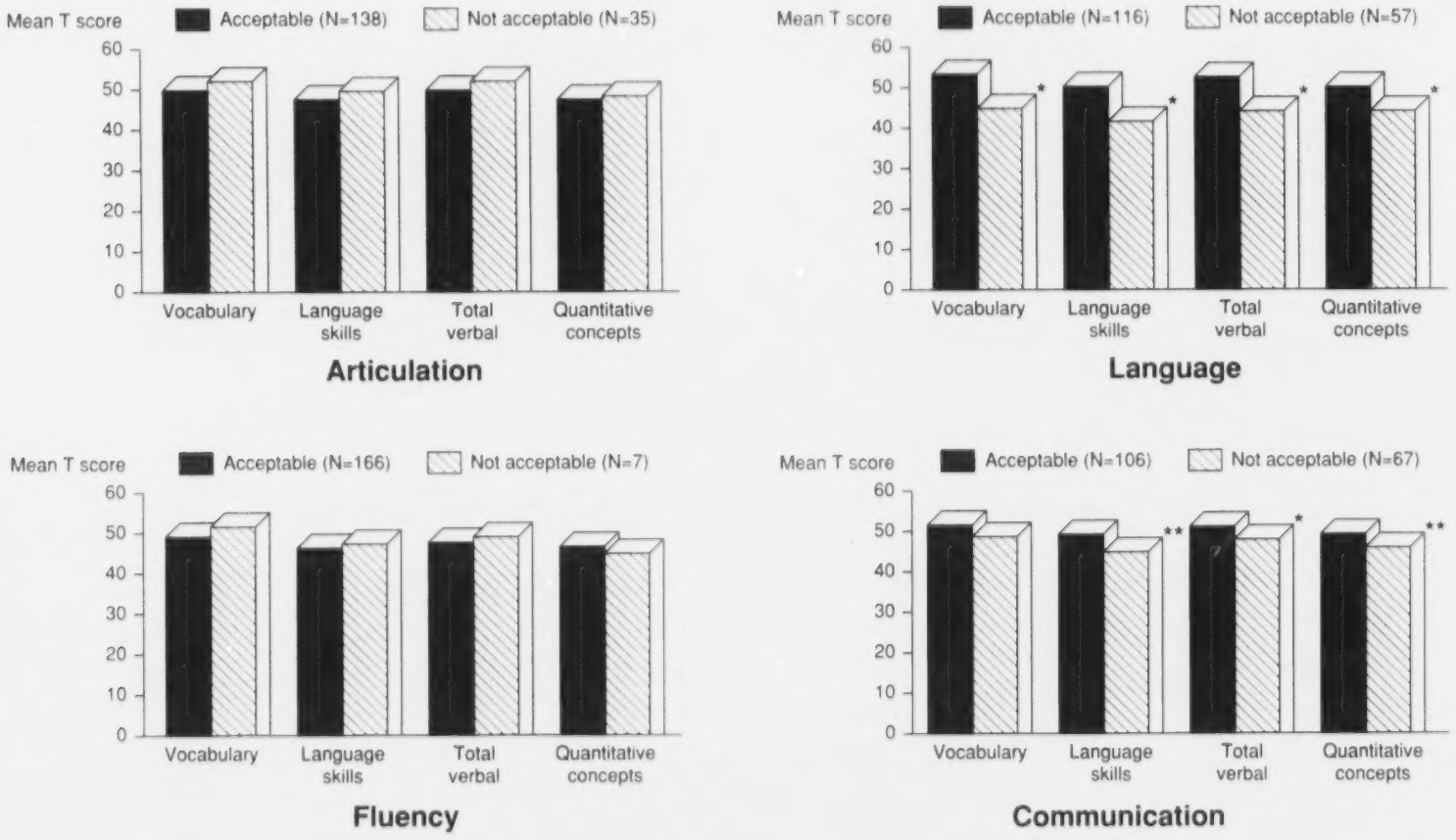
	Articulation		
	Acceptable (N=138)	Not Acceptable (N=35)	Significantly Different?
Vocabulary	49.2	51.4	No
Language Skills	46.2	47.8	No
Total Verbal	47.7	49.9	No
Quantitative Concepts	46.1	46.3	No

	Language		
	Acceptable (N=116)	Not Acceptable (N=57)	Significantly Different?
Vocabulary	52.2	44.3	Yes**
Language Skills	49.2	40.9	Yes**
Total Verbal	50.8	42.6	Yes**
Quantitative Concepts	48.2	42.0	Yes**

	Fluency		
	Acceptable (N=166)	Not Acceptable (N=7)	Significantly Different?
Vocabulary	49.5	51.9	No
Language Skills	46.5	47.1	No
Total Verbal	48.1	49.5	No
Quantitative Concepts	46.2	44.9	No

	Communication		
	Acceptable (N=106)	Not Acceptable (N=67)	Significantly Different?
Vocabulary	50.6	48.1	No
Language Skills	48.2	44.0	Yes**
Total Verbal	49.4	46.1	Yes*
Quantitative Concepts	47.5	44.1	Yes**

Note: Reported in T-score form.
* Significant at the .05 level.
** Significant at the .01 level.



Note: Reported in T score form **Significantly different at the .05 level* ***Significantly different at the .01 level*

Figure 12. Mean Test Scores by Speech Screening, Fall 1990

Table 12. Screening Results by Socio-Economic Status, 1990–91 School Year

	Socio-Economic Status						
	Low		Medium		High		
	N	%	N	%	N	%	Significantly Different?
Hearing Loss and Middle-Ear Disorder Screening							
Pass	10	15.2	26	39.4	30	45.5	
Possible Problem	9	32.1	13	46.4	6	21.4	
Fail	14	22.6	29	46.8	19	30.7	
Total	33	21.2	68	43.6	55	35.3	No
Speech Screening							
Acceptable	17	19.8	39	45.4	30	34.9	
Not Acceptable	16	22.9	29	41.4	25	35.7	
Total	33	21.2	68	43.6	55	35.3	No

Note: Significance test used for Hearing and Speech screening was chi-square.

Table 13. Comparison of Hearing Loss and Middle-Ear Disorder Screening Pass/Fail Groups on Health History Variables, Fall 1990

Health Variable	Audiometry			Tympanometry			Otoscopy			Acoustic Reflectometry			Summary Status						
	Pass N=112		Significantly different?	Pass N=127		Significantly different?	Pass N=42		Significantly different?	Pass N=20		Significantly different?	Pass N=73		Poss. Problem N=33		Fail N=66		Significantly different?
	Yes %	No %		Yes %	No %		Yes %	No %		Yes %	No %		Yes %	No %	Yes %	No %	Yes %	No %	
Birthweight																			
32-112 oz.	35.8	-		36.3	-		36.4	-		35.9	-		30.6	-	48.4	-	36.4	-	
113-128 oz.	30.3	-		33.1	-		31.8	-		33.3	-		33.3	-	22.6	-	39.4	-	
129+ oz.	33.9	-	No	30.6	-	No	31.8	-	No	30.8	-	No	36.0	-	29.0	-	24.2	-	No
Problems or complications during pregnancy or delivery																			
pregnancy	10.7	89.3	No	8.7	91.3	No	9.9	90.1	No	10.1	89.9	No	9.6	90.4	12.1	87.9	9.1	90.9	No
delivery	5.4	94.6	No	7.1	92.9	No	7.2	82.8	No	8.2	91.8	No	6.9	93.1	3.0	97.0	10.6	89.4	No
Child breastfed	73.9	26.1	No	73.0	27.0	No	74.6	25.5	No	71.5	28.5	No	80.6	19.4	54.6	45.4	68.2	31.8	Yes*
Use of bottle or pacifier when putting child to bed	20.5	79.5	No	19.7	80.3	No	19.8	80.2	No	19.5	80.5	No	19.2	80.8	21.2	78.8	18.2	81.8	No
Child have breathing problems	5.4	94.6	No	6.3	93.7	No	7.2	92.8	No	7.6	92.4	No	8.2	91.8	0.0	100.0	10.6	89.4	No
Child have problems talking	2.7	97.3	No	3.2	96.8	No	4.5	95.5	No	4.4	95.6	No	2.7	97.3	3.0	97.0	6.2	93.8	No
History of illness, ear infection and injury																			
high fever (103+)	46.9	53.1	No	43.7	56.3	No	45.5	54.5	No	44.3	55.7	No	45.8	54.2	42.4	57.6	40.9	59.1	No
ear infection	65.2	34.8	No	66.9	33.1	No	64.0	36.0	No	66.7	33.3	No	63.0	37.0	66.7	33.3	69.7	30.3	No
head injury	9.9	90.1	No	8.7	91.3	No	9.1	90.9	No	8.9	91.1	No	11.1	88.9	6.1	93.9	7.6	92.4	No
allergy	9.9	90.1	No	13.5	86.5	No	15.5	84.5	Yes*	12.0	80.0	No	13.9	86.1	3.0	97.0	13.6	86.4	No
asthma	5.3	84.7	Yes*	19.8	80.2	No	20.0	80.0	No	20.2	79.8	No	18.1	81.9	9.1	90.9	28.8	71.2	No
History of hospitalization or surgery	23.2	76.8	No	18.3	81.7	Yes*	22.7	77.3	No	22.8	77.2	No	19.2	80.8	24.2	75.8	29.2	70.8	No
Prior speech or hearing evaluation	47.8	52.2	No	45.2	54.8	No	46.2	51.8	No	46.2	53.8	No	54.2	45.8	33.3	66.7	37.9	62.1	No
Any concerns about child's speech or hearing	-	84.7	No	-	85.7	No	-	82.9	No	-	85.4	No	-	84.9	-	84.4	-	84.9	
hearing only	2.7	-		3.2	-		5.4	-		3.8	-		2.7	-	3.1	-	7.6	-	
speech only	9.9	-		8.7	-		7.2	-		8.2	-		9.6	-	9.4	-	4.6	-	
both speech and hearing	2.7	-	No	2.4	-	No	4.5	-	No	2.5	-	No	2.7	-	3.1	-	3.0	-	No
	Mean			Mean			Mean			Mean			Mean		Mean		Mean		
Number of months child breastfed	5.8	4.0	No	5.7	3.8	No	5.6	4.2	No	5.1	5.9	No	7.2		3.3		4.0		Yes*
Episodes of ear infection	3.7	4.6	No	3.9	4.4	No	4.2	3.8	No	4.0	4.6	No	3.8		2.9		4.8		No
Number of smokers in the house	0.9	1.0	No	0.8	1.2	Yes*	0.8	1.2	Yes*	0.9	0.8	No	0.8		1.0		1.1		No

Note: Significance test between Pass/Fail groups was chi-square, significance test used for mean number of months breastfed and mean episodes of ear infection was ANOVA.
*Significant at .05 level

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Table 14. Comparison of Hearing Loss and Middle-Ear Disorder Screening Pass/Fail Groups on Speech Screening Results, Fall 1990

	Audiometry			Tympanometry			Otoscopy			Acoustic Reflectometry			Summary Status			
	Pass N=111	Fail N=61	Significantly Different?	Pass N=127	Fail N=44	Significantly Different?	Pass N=111	Fail N=51	Significantly Different?	Pass N=158	Fail N=14	Significantly Different?	Pass N=13	Possible Problem N=33	Fail N=65	Significantly Different?
Articulation			No			No			No			No				No
Acceptable	78.4	82.0		81.1	75.0		75.7	86.9		80.4	71.4		75.3	81.5	83.1	
Retest	6.3	4.9		7.1	2.3		8.1	1.6		5.7	7.1		9.6	–	64.6	
Refer	15.3	13.1		11.8	22.7		16.2	11.5		13.9	21.4		15.1	18.2	12.3	
Language			No			No			No			No				No
Acceptable	73.9	55.7		69.3	61.4		65.8	70.5		68.4	57.1		69.9	78.8	58.5	
Retest	12.6	23.0		17.3	13.6		19.8	9.8		15.8	21.4		16.4	6.1	21.5	
Refer	13.5	21.3		13.4	25.0		14.4	19.7		15.8	21.4		13.7	15.2	20.0	
Fluency			No			No			No			No				No
Acceptable	94.6	98.4		96.1	97.7		95.5	96.7		95.6	100.0		94.5	97.0	98.5	
Retest	2.7	–		1.6	–		1.8	1.6		1.9	–		1.4	3.0	–	
Refer	2.7	1.6		2.4	2.3		2.7	1.6		2.5	–		4.1	–	1.5	
Voice			No			No			No			Yes*				No
Acceptable	95.5	93.4		96.1	90.9		96.4	91.8		95.6	85.7		94.5	97.0	93.9	
Retest	–	1.6		–	2.3		–	1.6		–	7.1		–	–	1.5	
Refer	4.5	4.9		3.9	6.8		3.6	6.6		4.4	7.1		5.5	3.0	4.6	
Communication			No			No			No			No				No
Acceptable	65.8	52.5		65.4	47.7		65.8	52.5		63.3	35.7		63.0	69.7	53.9	
Retest	15.3	23.0		17.3	20.5		18.9	16.4		17.7	21.4		20.6	6.1	21.5	
Refer	18.9	24.6		17.3	31.8		15.3	31.2		19.0	42.9		16.4	24.2	24.6	

Note: Figures are expressed as percentages. For the purposes of significance testing, retest and refer categories were combined into a not acceptable category. Frequencies for retest and refer are reported for descriptive purposes.
*Significant at .05 level

Table 15. Comparison of Hawaiian, Non-Hawaiian Preschoolers by Hearing, Speech, and Achievement Test Results, Fall 1990

	Hawaiian				Non-Hawaiian				
	Pass		Fail		Pass		Fail		Significantly
Hearing	N	%	N	%	N	%	N	%	Different?
Audiometry	88	66.7	44	33.3	20	57.1	15	42.9	No
Tympanometry	97	74.1	34	25.9	26	74.3	9	25.7	No
Acoust. Reflect.	124	93.9	8	6.1	30	85.7	5	14.3	No
Otoscopy	85	64.4	47	35.6	25	71.4	10	28.6	No
Summary Status	56	42.8	75	57.2	17	48.6	18	51.4	No

			Not				Not		
	Acceptable		Acceptable		Acceptable		Acceptable		Significantly
Speech	N	%	N	%	N	%	N	%	Different?
Articulation	108	82.4	23	17.6	24	68.6	11	31.4	No
Language	83	63.4	48	36.6	29	82.9	6	17.1	No
Fluency	124	94.7	7	5.3	35	100.0	–	–	No
Communication	77	58.8	54	41.2	23	65.7	12	34.3	No

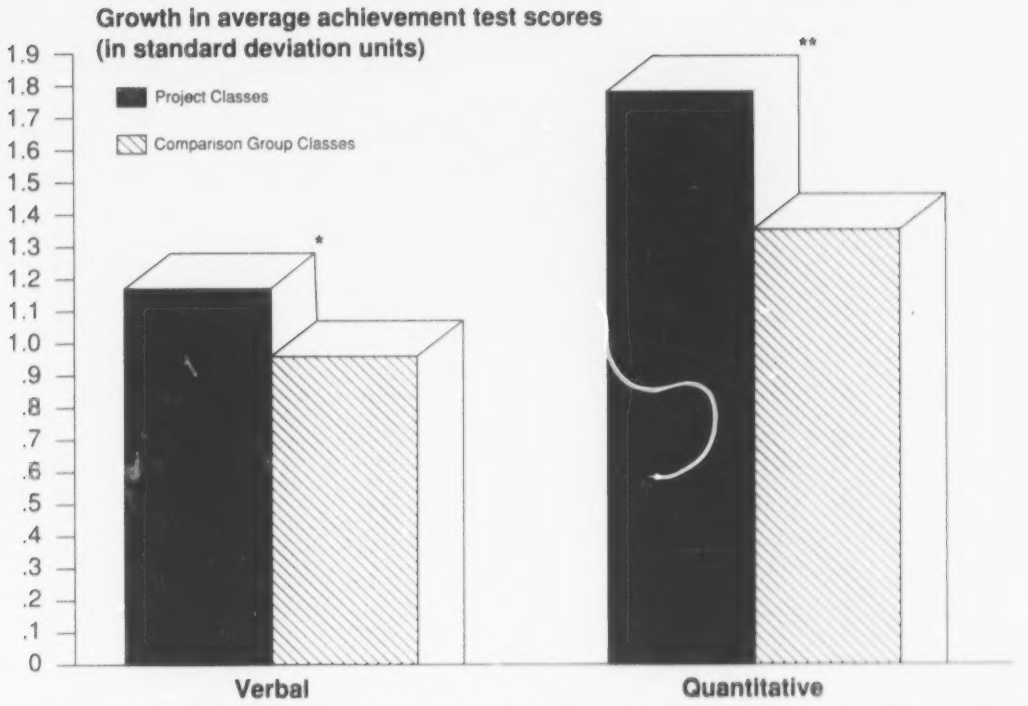
	Mean	Mean	Significantly
Test	T-score	T-score	Different?
Vocabulary	48.5	55.8	Yes**
Language Skills	45.7	50.5	Yes**
Total Verbal	47.2	53.1	Yes**
Quant. Concepts	45.4	50.6	Yes**

Note: Significance test used for Hearing and Speech data was chi-square; significance test used for mean test scores was ANOVA.
**Significant at .01 level.

Table 16. Significant Demographic and Health History Variables: Hawaiian and Non-Hawaiian Groups, Fall 1990

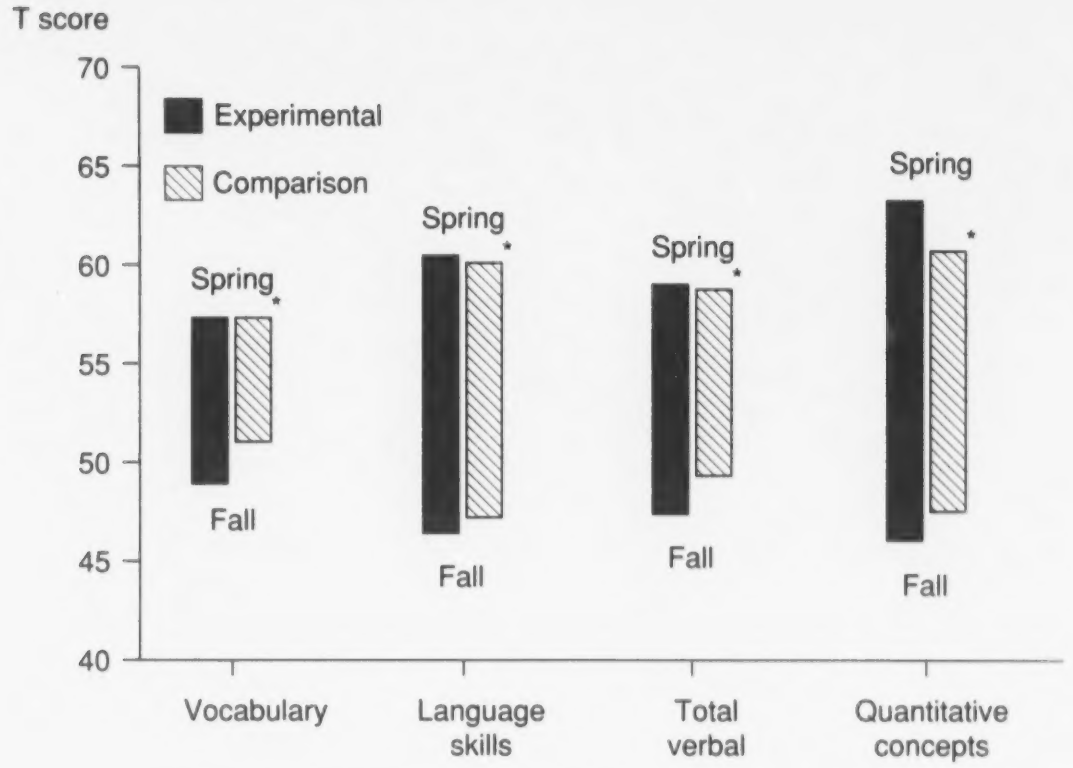
	Hawaiian		Non-Hawaiian		Significantly Different?
	Yes	No	Yes	No	
Demographic Variables					
Aid Recipient	38.1	61.9	10.8	89.2	Yes*
Both Parents in House	65.2	34.8	83.8	16.2	Yes*
Household Income					
Under $10,000	26.7	—	8.1	—	
$10,000 to $19,999	30.4	—	18.9	—	Yes*
$20,000 to $34,999	28.9	—	37.8	—	
$35,000 and over	14.1	—	35.1	—	
Health History Variables					
Ear Infections	69.7	30.3	51.4	48.6	Yes*
Head Injury	11.4	88.6	—	100.0	Yes*
Any concerns about your child's					
speech or hearing	13.8	86.3	22.9	77.1	
hearing only	3.1	96.9	11.4	88.6	
speech only	7.6	92.4	8.6	91.4	Yes*
speech & hearing	3.1	96.9	2.9	97.1	

Note: Significance test used was chi-square.
* Significant at .05 level.



Note: Verbal = PPVT-R + (language understanding + language usage + general knowledge)/3
Significantly different at the .05 level
***Significantly different at the .01 level*

Figure 13. KS/BE Preschool Project and Comparison Group Growth in Achievement Test Scores, 1990–91 School Year



*Significantly different at the .05 level
**Significantly different at the .01 level

Figure 14. Experimental and Comparison Group, 1990–91 Fall and Spring Achievement Test Results Reported as T Scores

CHAPTER IV
Discussion

To understand the implications of this research and demonstration project, it is necessary to be aware of its educational, cultural, and social context. First, the level of performance on tests of language competence (Standard English) by students of all ages and all ethnic groups in the state of Hawai'i is extremely low. For example, the typical child entering the public school kindergartens in the 1989–90 school year scored at the 18th percentile on the national norms of the Peabody Picture Vocabulary Test-Revised (see Figure 2). At the other end of the student-age span, Hawai'i ranked 46th out of 50 among the states in the most recent report of the College Board SAT-Verbal. When this type of ranking is corrected for socio-economic status, Hawai'i ranks last among all the states in performance on the SAT-Verbal. This pattern of very low language competence is evident on standardized tests administered at the intervening grade levels in the public schools.

Within this state-wide environment of low Standard English language competence, the population of native Hawaiian children has an even lower record of language test performance. In the same year the statewide average for kindergartners was at the 18th percentile, *Hawaiian* children scored at the *10th* percentile. Many other indicators of socio-economic, health, and educational status show that the Hawaiian population is at a serious disadvantage in comparison with both national and state general populations. These indicators reflect the familiar status of an indigenous people whose land-base, culture, and historic language have been overwhelmed by a different, dominant culture.

Given this context, it is not surprising that both low test scores and a high incidence of hearing/middle-ear disorder problems were found among the predominantly (83%) Hawaiian population of children entering Kamehameha Schools preschool program. The statewide hearing screening conducted by the Hawaii Department of Health (N=87, 956) finds a significantly higher failure rate for Hawaiian children. Though Hawaiians constitute 22% of the population screened at all grade levels, they represent 32% of those who fail.

However, analyses of these data revealed another phenomena that was not necessarily expected. That is, *within* this group of Hawaiian children there is a statistically significant relationship between screening results and language test scores. Hawaiian children are not only at a disadvantage in comparison to the general population, but also Hawaiian children who fail the screening are likely to have lower tests scores than those who pass.

This finding, confirmed over several school years, suggested the hypothesis that counteracting the negative educational effects of mild/moderate intermittent hearing loss might result in improved achievement test performance by Hawaiian preschoolers. That is the hypothesis that this project tested and affirmed.

We were not able to implement all six of the proposed interventions. We could not overcome the administrative barriers to the reduction of ambient noise and teachers could not be persuaded to use the acoustic otoscope with much frequency. However, the combination of other interventions: follow-up of screening to insure adequate medical care, parent newsletters and workshops, speech therapy, amplification in the classroom, classroom speech centers, and special teaching techniques, including the use of electronic speech trainers (Loquiturs) did result in significant effects.

The experimental group children showed nearly 25% more growth on verbal and quantitative achievement test scores than those in the comparison group.

This study was not designed to test the relative effectiveness of each of the different interventions. Indeed, there may well be multiplier effects among the interventions that would not be captured in a series of single-intervention studies. A study that tested for all single-intervention effects and all combinations (or interaction effects) would be of enormous size and complexity. A preschool wanting to make use of this project's findings will likely tailor a configuration of interventions that fits the physical and budgetary environment of its own setting.

A supplemental report will present cost data for various configurations of the interventions employed in this project. Similarly, other supplemental reports will present the findings of further analyses of the data that have been collected and of data yet to be gathered on the longitudinal comparison of experimental and comparison group children as they progress through the public schools.

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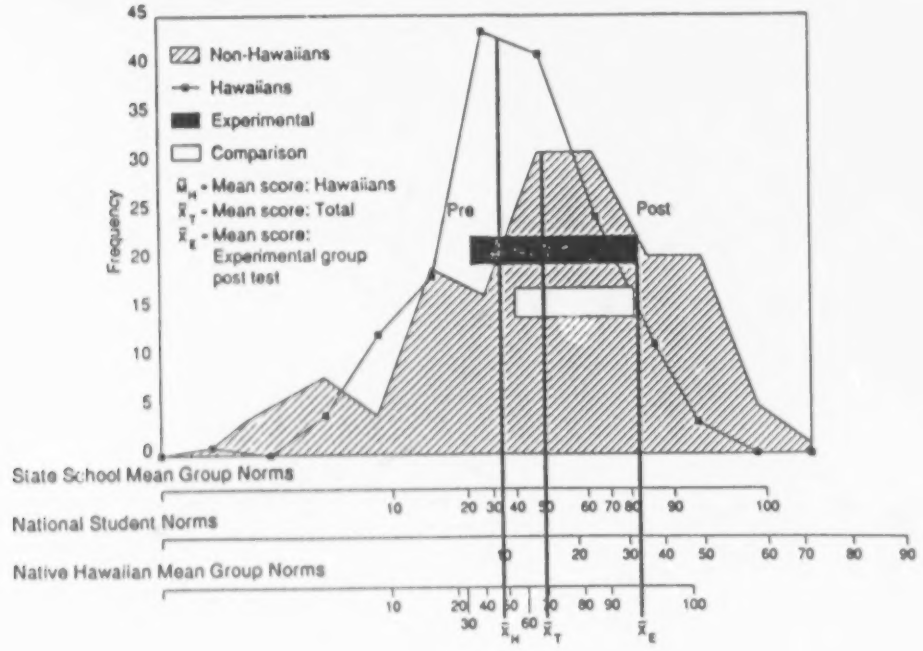
ERRATA

Page 19, Figure 2: The three scale lines below the Figure should be labelled

Top line:	**State School Mean Group Norms**
Middle line:	**National Student Norms**
Bottom line:	**Native Hawaiian Mean Group Norms**

On the original Figure, these scale lines were not labelled.



Page 44, Table 7: For the 1990-91 School Year, there was no significant difference (Sig. Dif.) between the Experimental and Comparison groups on Language Skills. The Sig. Dif. column (last column of the Table) should read NO. The original Table reads Yes.

Table 7. Mean Test Scores by Experimental and Comparison Groups, 1989–90 and 1990–91 School Years

Test	Fall Exp.	Fall Com.	Sig. Diff.	Spring Exp.	Spring Com.	Change Exp.	Change Com.	Sig. Diff.
				1989–90 School Year				
Vocabulary	48.9	50.6	No	56.4	55.3	7.4	4.7	Yes*
Language Skills	46.7	46.4	No	58.4	58.1	11.7	11.8	No
Total Verbal	47.7	48.5	No	57.3	56.7	9.6	8.2	No
Quant. Concepts	46.1	46.9	No	61.4	61.3	15.3	14.4	No
				1990–91 School Year				
Vocabulary	48.5	51.2	No	57.5	57.4	9.0	6.3	Yes*
Language Skills	46.3	47.2	No	60.6	60.2	14.4	13.0	No
Total Verbal	47.4	49.3	No	59.1	58.8	11.7	9.6	Yes*
Quant. Concepts	45.6	47.5	No	63.5	60.8	17.8	13.4	Yes**

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